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ERRATA.

Page 375 (note), line 19 from top, after "water," add "or metallic oxyd."
" " " " 18 from bottom, after "the" insert "gaseous."
" 422, dele last paragraph of note.
" 437, dele 5th and 6th lines from bottom.

Vol. XXIV, p. 314, 21 l. from bottom, for *propositions* read *proportions.*

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[SECOND SERIES.]

ART. I.—*On the Idea of Physical and Metaphysical Infinity*; by Lieut. E. B. HUNT, Corps of Engineers, U. S. A.

FEW subjects of reflection have engaged the meditative energies of so large a portion of the leading intellects of all ages as that great idea which under a vast diversity of forms and manifestations is expressed by the word infinity. So true is this, that the charge of rash confidence would naturally arise against whoever should now profess to contribute any great additional light where so much thinking has already been expended. In spite of this presumption, I shall venture some suggestions towards a precise definition of the idea of infinity, which have served to make clearer to my own mind what before was vague and indefinite.

It has seemed to me a correct criticism on the usual modes of considering the subject of infinity, that they regard it too exclusively under its metaphysical or speculative aspects, and too little in its physical or actualized forms. By at once pushing the idea of infinity into its abstract phases we banish it from our positive cognizance and relinquish the aids which nature affords in interpreting it to our finite comprehension. That such a hasty transfer from the concrete to the abstract form of contemplation involves a fault, may be appreciated at once by a simple consideration in which all healthful minds will doubtless agree. The idea of infinity must dwell in the divine creative mind in its greatest supposable perfection; consequently its natural embodi-

ments must possess a wholesome and intellectual truth far exceeding what could originate from the abstract speculations of human mind. Therefore, whatever hints towards a due appreciation of infinity can be gleaned from the contemplation of actual created nature, will rest on a more solid basis than any unguided speculations can claim.

Whatever is intrinsically measurable may by continuous quantitative expansion or diminution, grow to such an incomprehensible magnitude that infinity becomes predicable of its value. Thus time, distance, space, number, force, or any quality of matter or mind, as hardness, temperature, light producing power, sensational perceptive capacity, intellectual comprehension, force of will, benevolence, veneration, or indeed any species of actuality which can be regarded quantitatively, may be supposed so great or so small that the human mind will call it infinitely great or infinitely small. No such predicate would ever be used in speaking of what was not intrinsically measurable. Intrinsic measurability is therefore a fundamental preliminary to any concrete infinity. In other words, whatever is infinite must have a unit of measure, and its infinitude consists in the relation between its aggregate quantity and its unit of quantity. Physical infinities thus fundamentally involve homogeneous physical units of measure as standards of reference. Therefore the apprehension of infinity involves an apprehension of unity as its initial point, and this is equally true whether the magnitude called infinitely great or small is physical and actual, or metaphysical and only abstractly conceivable. Hence our first necessary step is to analyze the idea of a unit of measure.

When we speak of a foot, a cubic yard, a pound, an hour, a thermometer degree, &c., the ideas expressed are among the clearest which the human mind can entertain. Our mental and moral qualities, though intrinsically capable of equally exact units of measure, being actually without well defined units, their quantitative comparisons become vague and wanting in precision. Yet we are quite as prone to speak of infinite intelligence or infinite love as infinite distance or infinite time. This mode of speech rests on precisely as real a unit of measure as in the strictly physical cases, although it is less accurately defined to our own minds. If then we take a single instance of a unit of measure for close analysis, the general results of such a discussion will reach to all the analogous cases.

Taking the unit of lineal measure as this instance, we find that the original standards among all nations whence other units of length are derived, have a pretty close general agreement. The foot, the yard, the meter, the toise, &c. are all evident derivatives from the human body, and stand in close relations to certain convenient modes of measurement by reference to this geometry of the body.

Our optical perception of perspective distances involves an habitual process of reference of all dimensions seen, first to those distances near at hand which are readily comprehended, and in turn the reference of these to the actual lineal distance between the optical centres of the two eyes. This interocular distance, or stereoscopic base line, bears the same relation to exterior visible distances that the base line in a geodetic triangulation does to the entire network of the angles. Thus when we guage the perspective of a landscape, there is a direct visual perception or sensational measurement of external distances. Still we are so habituated to this stereoscopic function of the interocular base line that we do not make it an object of conscious contemplation, in our references of external distances to this base as a unit of measure. Such a reference however really enters as a vital part of every perspective perception, hence we are constantly applying unawares a standard measure, essentially constant for each individual during his whole life, to all external objects of our earthly surroundings. In like manner the length of our habitual step enters largely as a basis in our estimation of distances because we are constantly measuring distances seen, by our habitual mechanism of locomotion. Thus all our means of knowing external distances are found at last to rest solely on the actual dimensions of the human body to which as a standard they are referred.

Taking into account all the elements of our perception of lineal magnitudes, it will be found without doubt that the average lineal unit is very nearly that length which is most readily cognizable by a man of average person and capacities. High multiples and low submultiples of the standard of length are difficult of appreciation; thus a mile or a line are much less clearly apprehended units than a foot. If a thousand miles or a thousandth of a line is submitted to our consciousness, our notion becomes extremely inadequate, and if it be a million or a millionth we fail almost entirely to conceive the fact. When it is a question of billions or trillions of miles our apprehension is so totally at fault that we give over all attempts to comprehend the fact, and so the distance becomes infinite for us, as referred to the mile as a unit. Our real idea then is when we speak of an infinite or infinitesimal distance, that when it is compared with our familiar standard of length, our perceptive powers utterly fail to appreciate the relation with any approach to accuracy.

If in place of the unity and infinity of distance, we consider those of time, space or force, we shall find a like genesis of practical standard units for each, based on the actual dimensions or sensational capacities of the human organism. Along the graduated line of connection between those values which by their minuteness utterly elude our perception and those vast values

which in their entirety wholly transcend our comprehension, there is in each case a particular value which is apprehended with the maximum precision and facility by each individual mind. The natural unit of measure for each subject of measure is that particular value which is best appreciated by an average man. The same rule holds in the more transcendental subjects of measurement. Thus a man of average intellectual power and capacity becomes a natural unit of mentality, and a man of average morality becomes a unit of morality. If a particular moral quality, as benevolence, for instance, be quantitatively considered, we refer all to the man of average benevolence. When we speak of Divine Benevolence as infinite, we mean that it is so exhaustless and all prevailing, that when we compare it with the benevolence of an average man our limited human powers utterly fail to take in its relative immensity. From these considerations we may conclude that whenever we predicate infinity of any particular existence, attribute or quality of the external world, man's capacity to appreciate the various values of the subject matter considered, enters directly as the standard of comparison. Thus to say that space is infinite is simply to say that the extreme exercise of human power to perceive space as an existence is transcended by the actuality of nature. If we speak of infinite time we but declare that the brief periods of duration of which man in his earthly life is conscious are relatively so small that we can by no means conceive the number expressing the true ratio of man's hour or lifetime to the infinite duration referred to.

Whatever physical infinity engages our consideration, an analogous limitation of the special powers of the human organism is defined. We might almost say that for us, the grand sphere of physical infinity is the circumscribing sphere drawn around the aggregate perceptive faculties of man. It is not at all the absolute cosmos or circumscribing sphere which contains all the actualities of nature. We may well believe that this true cosmic sphere in which all created existence is contained is itself an infinity as compared with that specific infinity which is as it were the defining or tangent surface around the faculties of man.

It is entirely supposable that among the actual organic existences of nature, there may be numerous successive grades of perceptive capacity which stand in the relation of coterminous or successive infinities as compared with each other. A monad may have a direct perception of man's infinitely small, and our sensible distance must be to it an infinitely great magnitude. There may be intelligences such that the radius of an ultimate atom of matter would be to them what the radius of the earth is to us, as there may be intelligences to which the earth is but an atom

and to which our entire sphere of visible stars makes but a sensible mass of matter. Throughout the entire range of organic existence there will be in fact for each species a specific infinity, and we cannot say but in the treasure house of the actual universe, there may be an infinite series of organic perceptive powers which bear to each other the relation of the successive orders of differences in differential calculus. Whatever may be the fact as to actual nature, such an infinite series of successive infinities is metaphysically conceivable. The clear apprehension of the idea of infinity which may be gleaned from physical grounds gives a basis for indefinite metaphysical fabrications without in the least departing from the true inductive idea of infinity. But science has not to deal with the supposable except as it is involved in the actual, and it belongs not to this place or to true philosophy to go beyoud the foundations of fact.

The views now presented have a bearing on the mathematical idea of infinity which is not without importance. The mathematical symbol of infinity stands for an entirely abstract idea. From it all the definite standards of unity which have been discussed are entirely eliminated, all specific intelligences are in it ignored, and even the Divine Intelligence may be supposed in some way concrete in conditions too specific to be truly stated in respect to limits, by the abstract infinity of pure analysis. The very possibility of positive definition as applied to any being however exalted, excludes the abstract symbol of infinity from entering a correct exegesis of its nature. For what then does the abstract symbol of infinity stand? It at least stands as a formula for all specific infinities which by the interpolation of the proper constants expresses the quantitive relations in any actual case of infinity. The abstract symbol is a grouping of specific cases: whether it is more than this may not be for man to say.

One inference from these views of infinity is that the ordinary definition of the asymptotic curve needs correction. The mathematical formula of incessant and incessantly diminishing approach between a straight line and a curve or between two curved lines, or the same relative to plane and curved surfaces is not consistent with the other idea of tangency at an infinite distance. Suppose an intellect of the proper or differential grade to be duly cognizant of asymptotic lines at an infinite distance; it would find no actual contact, but the same law of approach expressed in the analytical formula would still go on until an intellect of the second differential order would have to be called in as the cognizant power: this in turn must give place to a third differential intellect, and so on to infinity. The order of perceptions required to appreciate the second, third, &c. differentials of the function would be progressively higher than that demanded for the differentials of the variable. Here then there is no true tan-

gency but a perpetually decreasing approximation. Hence the definition of asymptotes should give the idea of a perpetually diminishing and never ending approximation instead of involving the false notion of tangency anywhere. The geometrical method of exhaustions escapes any such criticism and in the purest manner embodies the true conception of infinity.

As might be expected, the infinitesimal calculus expresses the notion of infinity in its most precise and purified form. The fundamental idea on which its processes and algorithm rest, is one of relation between quantities cognizable by two orders of perception, so remote that the finite quantity of the one is the infinitely great or small of the other. By the hypothecation of three, four or more coterminous orders of perceptive faculty the second, third, &c. orders of differences are philosophically originated. The relations of differential calculus if inversely stated become those of integral calculus, and fall under the same generalizations relative to orders of perceptive capacity. I will venture the suggestion that the reason why some eminent mathematicians have contended that a differential is absolutely zero, is simply because of their not having regarded, as they clearly are bound to do, the element of limited perceptive faculties which infinity involves and the consequently supposable series of cognitions precisely conforming with first, second, third, &c. differentials. It is the same fault of conception which invalidates the definition of asymptotes based on tangency at an infinite distance.

In conclusion, we may lay down the general proposition that the idea of infinity involves in all cases as an essential factor in its composition, a specific actual or hypothetical limitation of perceptive power in the intelligence of whose cognitions infinity is predicated. In the physical infinities which chiefly interest us, the limitations involved are *for us*, altogether those which encompass the mind of man. We can by hypothesis suppose other limits conformed to other grades of organisms, and we can even suppose such an exalted spiritual organism as that the absolute and entire cosmos shall be the true limit of its perceptive powers. Before the divine mind this cosmos must stand in that clear finite relation necessarily supposed between a creator and the thing created. Beyond the actual cosmos there may be an immensity of possibility where the divine mind may realize analogous limitations to those which hedge in all created minds. In the mathematical or purely abstract idea of infinity there seems a suggestion of such a possibility, and when we consider that a mathematical formula is the nearest possible approach to a literally divine thought, we shall bow with reverence before the suggestion shadowed forth by the sublime symbol of infinity after all created limitations are eliminated from its significance.

This symbol affords no basis for the commonly received idea that infinity means an absolute unboundedness, a quantity absolutely without end, a quality or nature transcending *all* boundaries. Such an idea has no right in the mind of man, for the limitations of human perception forbid our attainment of any knowledge either of the extent of the absolute cosmos or of the boundaries around what is abstractly possible. The formula of infinity, so far from stating an absolute boundlessness, endlessness or illimitable magnitude, states simply the limitations of finite perceptive power. It is the expression, not of the immeasurableness of nature or of the Deity, but of the finite limitations of the human mind. It stands for a negative and not for a positive: it symbolizes not knowledge but ignorance. If we group infinite attributes under a divine name, we have not defined Deity but we have defined the limits of our own conceptions. The limits of our knowledge lie near at hand: the limits of our ignorance are known only to the All-knowing.

ART. II.—*On the Characters, Principles of Division, and Primary Groups of the Class Mammalia;* by Professor OWEN, F.R.S., F.L.S., Superintendent of the Natural History Departments in the British Museum.*

THE class Mammalia, the most highly organized of the animal kingdom and that to which we ourselves belong, appears to have been the class of animals last introduced on this planet, and not to have attained plenary development until the tertiary division of geological time.

Mammals are distinguished, outwardly, by an entire or partial covering of hair, and (with two exceptions) by teats or mammæ —whence the name of the class.† All Mammals possess mammary glands, and suckle their young: the embryo or fœtus is developed in the womb. Their leading anatomical character is to have lungs, composed of a highly vascular and minutely cellular structure throughout, and suspended freely in a thoracic cavity separated by a muscular and tendinous septum or diaphragm from the abdomen.

Mammals, like birds, have a heart composed of two ventricles and two auricles, and have warm blood: they breathe quickly; but inspiration is performed chiefly by the agency of the diaphragm; and the inspired air acts only on the capillaries of the pulmonary circulation.

* This paper is cited from the Journal of the Proceedings of the Linnean Society of London. Read February 17th and April 21st, 1857.

† From *mamma*, a pap. The Platypus and Echidna are the only known exceptions to this rule. The Mare is an apparent one, from the pudendal position of the nipples. The fœtal Cetacea show tufts of hair on the muzzle.

The blood-discs are smaller than in Reptiles, and, save in the camel-tribe, are circular. The right auriculo-ventricular valve is membranous, at least never entirely fleshy; and the aorta bends over the left, never over the right, bronchial tube. The primary branches of the aorta are given off not immediately after, but at a little distance from, its origin, and there is less constancy in the order of their origin than in Birds: the phrenic arteries, the cœliac axis, and the superior mesenteric artery are always branches of the abdominal aorta, which terminates by dividing beyond the kidneys into the iliac arteries, from which spring both the femoral and ischiadic branches: the caudal or sacro-median artery, which in some long-tailed Mammals assumes the character of the continued trunk of the aorta, never distributes arteries to the kidneys or the legs, as in Birds. The kidneys are nourished, and derive the material of their secretion, exclusively from the arterial system. Their veins are simple, commencing by minute capillaries in the parenchyma and terminating generally by a single trunk on each side in the abdominal vena cava: they never anastomose with the mesenteric veins.

The kidneys are relatively smaller and present a more compact figure than in the other vertebrate classes; their parenchyma is divided into a cortical and medullary portion, and the secreting tubuli terminate in a dilatation of the excretory duct, called the pelvis.

The liver is generally divided into a greater number of lobes than in Birds. The portal system is formed by veins derived exclusively from the spleen and chylopoietic viscera. The cystic duct, when it exists, always joins the hepatic, and does not enter the duodenum separately. The pancreatic duct is commonly single.

The mouth is closed by soft flexible muscular lips: the upper jaw is composed of palatine, maxillary and premaxillary bones, and is fixed; the lower jaw consists of two rami, which are simple or formed by one bony piece, and are articulated by a convex or flat condyle to the base of the zygomatic process, and not to the tympanic element of the temporal bone; the base of the coronoid process generally extends along the space between the condyloid and the alveolar processes. The jaws of Mammals, with few exceptions, are provided with teeth, which are arranged in a single row; they are always lodged in sockets, and never anchylosed with the substance of the jaw. The tongue is fleshy, well-developed, with the apex more or less free. The posterior nares are protected by a soft palate, and the larynx by an epiglottis: the rings of the trachea are generally cartilaginous and incomplete behind: there is no inferior larynx. The œsophagus is continued without partial dilatations to the stomach, which varies in its structure according to the nature of the food, or the quantity of nutriment to be extracted therefrom.

The true vertebræ of Mammalia have their bodies ossified from three centres, and present for a longer or shorter period of life a discoid epiphysis at each extremity. They are articulated by concentric ligaments with interposed glairy fluid forming what are called the intervertebral substances; the articulating surfaces are generally flattened, but sometimes, as in the neck of certain Ruminants, they are concave behind and convex in front: such a vertebra, however, may be distinguished from a vertebra of a Reptile, with a similar ball-and socket structure of the articular surfaces, even when found in a fossil state, and when the test of the articulating medium cannot be applied, by the complete anchylosis or confluence of the annular with the central part or body, and by the large relative size of the canal for the spinal chord. The cervical vertebræ, with one or two exceptions, are seven in number, neither more nor less: the Monotremes, which are the instances commonly opposed to other generalizations, form no exception to this rule. The lumbar vertebræ are more constant and usually more numerous than in other classes of vertebrate animals. The atlas is articulated by concave articular processes to two convex condyles, which are developed from the ex-occipital elements of the last cranial vertebra. The typanic element of the temporal bone is restricted in function to the service of the organ of hearing, and never enters into the articulation of the lower jaw. The olfactory nerves escape from the cranial cavity through numerous foramina of a cribriform plate. The optic foramina are always distinct from one another.

The scapula is generally an expanded plate of bone; the coracoid, with two (monotrematous) exceptions, appears as a small process of the scapula. The sternum consists of a narrow and usually simple series of bones: the sternal portions of the ribs are generally cartilaginous and fixed to the vertebral portions without the interposition of a distinct articulation: there are no gristly or bony abdominal ribs or abdominal sternum. The pubic and ischial arches are generally complete, and united together by bony confluence on the sternal aspect, so that the interspace of the two pelvic arches is converted into two holes, called *foramina obturatoria* or *thyroidea*. The sclerotic coat of the eye is a fibrous membrane, and never contains bony plates. In the quantity of aqueous humor and the convexity of the lens Mammals are generally intermediate between Birds and Fishes. The organ of hearing is characterized by the full development of the cochlea with a lamina spiralis: there are three distinct ossicles in the tympanum; the membrana tympani is generally concave externally; the meatus auditorius externus often commences with a complicated external ear, having a distinct cartilaginous basis. The external apertures of the organ of smell

are provided with movable cartilages and muscles, and the extent of the internal organ is increased by accessory cavities or sinuses which communicate with the passages including the turbinated bones.

There are few characters of the osseous system common, and at the same time peculiar, to the class Mammalia. The following may be cited:

1. Each half or ramus of the mandible consists of one bony piece developed from a single centre: the condyle is convex or flat, never concave. This has proved a valuable character in the determination of fossils.

2. The second or distal bone, called "squamosal," in the bar continued backwards from the maxillary arch, is not only expanded, but is applied to the side-wall of the cranium, and develops the articular surface of the mandible, which surface is either concave or flat.*

3. The presphenoid is developed from a centre distinct from that of the basisphenoid.

In no other class of vertebrate animals are these osteological characters present.

The cancellous texture of mammalian bone is of a finer and more delicate structure than in Reptiles, and forms a closer network than in Birds. The microscopic radiating cells are relatively smaller and approach more nearly to the spheroid form; but both these histological characters are liable to mislead, if unsupported by more obvious and constant ones, in the interpretation of a fossil.

Dental characters.—The Mammalia, like *Reptilia* and *Pisces*, include a few genera and species that are devoid of teeth; the true ant-eaters (*Myrmecophaga*), the scaly ant-eaters or pangolins (*Manis*), and the spiny monotrematous ant-eater (*Echidna*), are examples of strictly edentulous Mammals. The Ornithorhynchus has horny teeth, and the whales (*Balæna* and *Balænoptera*) have transitory embryonic calcified teeth, succeeded by whalebone substitutes in the upper jaw. The female Narwhal seems to be edentulous, but has the germs of two tusks in the substance of the upper jaw-bones; one of these becomes developed into a large and conspicuous weapon in the male Narwhal, whence the name of its genus *Monodon*.

The examples of excessive number of teeth are presented, in the order *Bruta*, by the priodont Armadillo, which has ninety-eight teeth: and in the Cetaceous order by the Cachalot, which has upwards of sixty teeth, though most of them are confined to the lower jaw; by the common Porpoise, which has between eighty and ninety teeth; by the Gangetic Dolphin, which has one hundred and twenty teeth; and by the true Dolphins (*Del-*

* The Wombat is, perhaps the sole exception to this rule.

phinus), which have from one hundred to one hundred and ninety teeth, yielding the maximum number in the class Mammalia.

When the teeth are in excessive number, as in the Armadillos and Dolphins above cited, they are small, equal, or sub-equal, and usually of a simple conical form.

In most other mammals particular teeth have special forms for special uses; thus, the front teeth, from being commonly adapted to effect the first coarse division of the food, have been called cutters or *incisors;* and the back teeth, which complete its comminution, grinders or *molars;* large conical pointed teeth situated behind the incisors, and adapted, by being nearer the insertion of the biting muscles, to act with greater force, are called holders, tearers, laniaries, or more commonly *canines*, from being well developed in the Dog and other Carnivora.

It is peculiar to the class Mammalia to have teeth implanted in sockets by two or more fangs; but this can only happen to teeth of limited growth, and generally characterizes the molars and pre-molars: perpetually growing teeth require the base to be kept simple and widely excavated for the persistent pulp. In no mammiferous animal does anchylosis of the tooth with the jaw constitute a normal mode of attachment. Each tooth has its peculiar socket, to which it firmly adheres by the close coadaptation of their opposed surfaces, and by the firm adhesion of the alveolar periosteum to the organized cement which invests the fang or fangs of the tooth.

True teeth implanted in sockets are confined, in the Mammalian class, to the maxillary, premaxillary, and mandibular or lower maxillary bones, and form a single row in each. They may project only from the premaxillary bones, as in the Narwhal; or only from the lower maxillary bone, as in *Ziphius;* or be limited to the superior and inferior maxillaries and not present in the premaxillaries, as in the true *Ruminantia* and most *Bruta* (Sloths, Armadillos, Orycteropes). In most Mammals, teeth are situated in all the bones above mentioned.

The teeth of the Mammalia usually consist of hard unvascular dentine, defended at the crown by an investment of enamel, and everywhere surrounded by a coat of cement.

The coronal cement is of extreme tenuity in Man, Quadrumana and the terrestrial Carnivora; it is thicker in the Herbivora, especially in the complex grinders of the Elephant.

Vertical folds of enamel and cement penetrate the crown of the tooth in the ruminating and many other Ungulata, and in most Rodents, characterizing by their various forms the genera of those orders.

No Mammal has more than two sets of teeth. In some species the tooth-matrix does not develop the germ of a second

tooth, destined to succeed one into which the matrix has been converted; such a tooth, therefore, when completed and worn down, is not replaced. The Sperm Whales, Dolphins, and Porpoises are limited to this simple provision of teeth. In the Armadillos and Sloths, the want of generative power, as it may be called, in the matrix is compensated by the persistence of the matrix, and by the uninterrupted growth of the teeth.

In most other Mammalia, the matrix of the first-developed tooth gives origin to the germ of a second tooth, which sometimes displaces the first, sometimes takes its place by the side of the tooth, from which it has originated.

All those teeth which are displaced by their progeny are called 'temporary,' deciduous, or milk-teeth; the mode and direction in which they are displaced and succeeded, viz. from above downwards in the upper, from below upwards in the lower, jaw, in both jaws vertically—are the same as in the Crocodile; but the process is never repeated more than once in any mammalian animal. A considerable proportion of the dental series is thus changed; the second or 'permanent' teeth having a size and form as suitable to the jaws of the adult, as the 'temporary' teeth were adapted to those of the young animal.

Those permanent teeth, which assume places not previously occupied by deciduous ones, are always the most posterior in their position, and generally the most complex in their form. The term 'molar' or 'true molar' is restricted to these teeth. The teeth between them and the canines are called 'premolars;' they push out the milk-teeth that precede them, and are usually of smaller size and simpler form than the true molars.

Thus the class Mammalia, in regard to the times of formation and the succession of the teeth, may be divided into two groups, *monophyodonts*,* or those that generate a single set of teeth; and the *diphyodonts*,† or those that generate two sets of teeth. But this dental character is not so associated with other organic characters as to indicate natural or equivalent subclasses.

In the Mammalian orders with two sets of teeth, these organs acquire fixed individual characters, receive special denominations, and can be determined from species to species. This individualization of the teeth is eminently significative of the high grade of organization of the animals manifesting it.

Originally, indeed, the names 'incisors,' 'canines,' and 'molars,' were given to the teeth, in Man and certain Mammals, as in Reptiles and Fishes, in reference merely to the shape and offices indicated by these names; but they are now used as arbitrary signs, in a more fixed and determinate sense. In some

* *μόνος*, once; *φύω*, I generate; *ὀδούς*, tooth.

† *δίς*, twice; *φύω* and *ὀδούς*. See "Philosophical Transactions," 1850, p. 493.

ra, *e. g.* the front-teeth have broad tuberculate summits, for nipping and bruising, while the principal back-teeth ed for cutting, and work upon each other like the blades rs. The front-teeth in the Elephant project from the w, in the form, size and direction of long pointed horns. , shape and size are the least constant of dental charache Mammalia; and the homologous teeth are determined, er parts, by their relative position, by their connexions, their development.

teeth which are implanted in the premaxillary bones, he corresponding part of the lower jaw, are called 'incihatever be their shape or size. The tooth in the maxillary ich is situated at or near to the suture with the premax- the 'canine,' as is also that tooth in the lower jaw, in opposing it, passes in front of the upper one's crown e mouth is closed. The other teeth of the first set are ciduous molars;' the teeth which displace and succeed rtically are the 'premolars;' the more posterior teeth, re not displaced by vertical successors, are the 'molars' y so called.

e been led, chiefly by the state of the dentition in most early forms of both carnivorous and herbivorous Mamwhich flourished during the eocene tertiary periods, to 3 incisors, 1 canine, and 7 succeeding teeth, on each side jaws, as the type formula of diphyodont dentition.

of the seven teeth may be 'premolars,' and four may 'molars;' or there may be four premolars, and three true This difference as I have elsewhere shown, forms a er of a secondary group or order in the mammalian class.* ential nature of the distinction is as follows: true molars ackward continuation of the first series of teeth; they eloped in the same primary groove of the fœtal gum; e 'permanent' because they are not pushed out by sucl teeth—the 'premolars,' called 'dents de remplacement' ier. Seven teeth developed in the primary groove is, re, the typical number of first teeth, beyond the canines. in *Didelphys*, the anterior three develop tooth-germs, come to perfection in a 'secondary groove,' there are then uous teeth, 3 premolars, and 4 true molars: if, as in *ra*, the anterior four of the 'primary' teeth develop erms, which grow in a secondary groove, there are then uous teeth, 4 premolars, and 3 true molars. The first olar of the marsupial is thus seen to be the homologue of t milk-molar of the placental.

Gymnure, the Mole, and the Hog are among the few exquadrupeds which retain the typical number and kinds of

lines of a Classification of the Mammalia, Trans. Zool. Soc. vol. ii, p. 330

teeth. In a young Hog of ten months, the first premolar, *p.* 1, and the first molar, *m.* 1, are in place and use together with the three deciduous molars, *d.* 2, *d.* 3, and *d.* 4; the second molar, *m.* 2, has just begun to cut the gum; *p.* 2, *p.* 3, and *p.* 4, together with *m.* 3, are more or less incomplete, and will be found concealed in their closed alveoli.*

The last deciduous molar, *d.* 4, has the same relative superiority of size to *d.* 3 and *d.* 2, which *m.* 3 bears to *m.* 2 and *m.* 1; and the crowns of *p.* 3 and *p.* 4 are of a more simple form than those of the milk-teeth, which they are destined to succeed. When the milk-teeth are shed, and the permanent ones are all in place, their kinds are indicated, in the genus *Sus*, by the following formula:—

$$i.\ \frac{3-3}{3-3},\ c.\ \frac{1-1}{1-1},\ p.\ \frac{4-4}{4-4},\ m.\ \frac{3-3}{3-3}=44:$$

which signifies that there are on each side of both upper and lower jaws 3 incisors, 1 canine, 4 premolars, and 3 molars, making in all 44 teeth, each tooth being distinguished by its appropriate symbol, e. g., *p.* 1 to *p.* 4, *m.* 1 to *m.* 3. This number of teeth is never surpassed in the placental Diphyodont series.

When the premolars and the molars are below this typical number, the absent teeth are missing from the fore part of the premolar series, and from the back part of the molar series. The most constant teeth are the fourth premolar and the first true molar; and these being known by their order and mode of development, the homologies of the remaining molars and premolars are determined by *counting the molars from before backwards*, *e. g.* 'one,' 'two,' 'three,' and the premolars *from behind forwards*, 'four,' 'three,' 'two,' 'one.' The incisors are counted from the median line, commonly the foremost part, of both upper and lower jaws, outwards and backwards. The first incisor of the right side is the homotype, tranversely, of the contiguous incisor of the left side in the same jaw, and vertically of its opposing tooth in the opposite jaw; and so with regard to the canines, premolars, and molars; just as the right arm is the homotype of the left arm in its own segment, and also of the right leg of a succeeding segment. It suffices, therefore, to reckon and name the teeth of one side of either jaw in a species with the typical number and kinds of teeth, *e. g.* the first, second, and third incisors,—the first, second, third, and fourth premolars,—the first, second, and third molars; and of one side of both jaws in any case.

* I recommend this easily acquired 'subject' to the young zoologists for a demonstration of the most instructive peculiarities of the mammalian dentition. He will see that the premolars must displace deciduous molars in order to rise into place: the molars have no such relations.

I have been induced to dwell thus long on the dental charac-
'8 of the class *Mammalia*, because they have not been clearly
accurately defined in any systematic or elementary work on
ology, although an accurate formula and notation of the teeth
e of more use and value in characterizing genera in this than
any other class of animals.

I next proceed to review briefly the principal primary divi-
ons of the *Mammalia* hitherto proposed. The best authorities
Natural History have adopted different characters, drawn from
fferent systems of organs, for the primary groups or divisions
' the class *Mammalia*.

Aristotle chose the locomotive system, and divided his Zo-
roka—the equivalent of the Linnean Mammalia—into three
ctions: 1st, Dipoda, or bipeds; 2nd, Tetrapoda, or quadru-
eds; and 3d; Apoda, or impeds. The preponderating second
oup, which includes all the class save the Human-kind and
e Whale-tribe, is subdivided into those with claws, and those
ith hoofs. The unguiculate quadrupeds are again subdivided
cording to the nature of their teeth; the ungulate quadrupeds,
cording to the divisions of their hoofs, as *e. g.* into *Polyschidæ*,
· multungulates, *Dischidæ*, or bisulcates, and *Aschidæ*, or solid-
ngulates. I need scarcely remark that this, in most respects
lmirable, system, would have commanded greater attention,
id been now recognized as more manifestly the basis of later
stems, had its immortal author more technically expressed his
opreciation of the law of the subordination of characters; but
e applies to each of his groups, whatever their value, the same
enomination, viz. *genos*, or genus.

Ray, with a less philosophical appreciation of the extent and
ature of the class *Zootoka* or *Mammalia*, arranges his equivalent
roup of "Viviparous Four-footed animals" chiefly on the Aris-
telian characters; the primary division being into Ungulate
ad Unguiculate, and the subdivisions being based on locomo-
ve and dental characters.

Linnæus, restoring the class *Mammalia* to its Aristotelian in-
grity, primarily subdivides it into Unguiculata, Ungulata,
ad Mutica, the latter being the 'Apoda' of Aristotle: the
econdary groups or orders are founded chiefly on modifications
f the dental system.

Cuvier, adopting the same threefold primary division of the
lass, subdivides it into better and more naturally defined orders,
ccording to various characters derived from the dental, the
sseous, generative, and the locomotive systems.

Illiger, in primarily dividing the Mammalia into those with
ree, and those with fettered limbs—the 'pedes exserti distincti,'
contrasted with the 'pedes retracti obvoluti,'—made a more
unequal and less natural partition than the threefold one of Aris-

totle; the Seals and the Whales balance all the rest of the class in the Illigerian system. The subdivisions, also of these primary groups, based exclusively on characters of locomotion, have met with little acceptance beyond some of the schools of Germany.

De Blainville appears first, 1816, to have adopted a character from the reproductive system for the primary division of the Mammalia, viz. into the 'Monodelphes,' 'Didelphes,' and 'Ornithodelphes.' His orders are in the main a return to the Linnean system and nomenclature, with some peculiar views, as *e. g.* of the quadrumanous or primatial affinity of the Sloths, which have never gained acceptance. But his system indicates a clearer appreciation or stronger conviction of the value of the character of parity and imparity in the number of toes of the *Ungulata*, first suggested by Cuvier,* than was subsequently entertained by the originator of the idea.

The position of the marsupial and monotrematous quadrupeds at the bottom of the class *Mammalia*, and the higher value assigned to the group which they constituted, than that in the 'Règne Animal' of Cuvier, were ideas also in closer conformity with nature. They were, however, but surmises, unsustained by anatomical knowledge; and, as such, failed to carry conviction, or gain acceptance. Nor was it until comparative anatomy had shown that the Marsupials and Monotremes agreed in differing from all other mammals in the absence of a placenta, and of the great commissure of the brain, in certain bird-like characters of the heart,† and from all other diphyodont Mammals in a less number of premolars, and a greater number of true molars,—depending essentially on the retention of a milk-tooth (*m.* 4), which is displaced and changed in the placental diphyodonts,—that the true affinities of the didelphid and ornithodelphid mammals to each other, and their true position in the class *Mammalia*, were finally recognized.

In the 'Systema Vertebratorum,' communicated in 1840 to the Linnean Society by that accomplished and indefatigable zoologist Prince Charles Lucien Bonaparte, the primary subdivision of the Mammalia according to developmental and generative characters is adopted; and the first division or series *Placentalia* is subdivided, agreeably with M. Jourdan's distribution of Mammalia in the Leyden Museum, into the two subclasses *Educabilia* and *Ineducabilia*, the latter including the orders *Bruta*, *Cheiroptera*, *Insectivora* and *Rodentia*, with the common character of 'cerebrum unilobum.' This I regard as the most important improvement in the classification of the Mammalia, which has been proposed since the establishment of the natural character of the implacental or ovo-viviparous division.

* Ossemens Fossiles. 4to, ed. 1812, p. 9; tom. iii, ed. 1822, p. 72.

† On the Classification of the *Marsupialia*, Zoological Transactions, vol. ii, p. 315 (1839).

er had early noticed the relation of the Australian mam- s a small collateral series, to the unguiculate mammals of of the world, "some," he writes, "corresponding with *naria*, some with the *Rodentia*, and others again with the *a*."*

idore Geoffroy St. Hilaire, in his 'Classification parallèl- s Mammifères,' published in 1845, raises the *Marsupialia*, ank of a distinct class, and literally exemplifies the idea er by placing its subdivisions, as orders, in parallel equiv- vith the orders of the *Placentalia*.

es not appear, however, that Cuvier meant to do more dicate certain relations of analogy; just as the relation of limanous and frugivorous Marsupials to the pedimanous *mana* of S. America, that of the marsupial Hyæna (*Thy-* to the Wolf, of the Flying Petaurist to the Flying l, of the Wombat to the Beaver, of the Kangaroo to the ant, of the Koala to the phytiphagous Sunbear, of the ms to the Shrews, and of the Echidna to the Anteater, d been pointed out by myself. My esteemed friend and ue Mr. Waterhouse, whilst admitting the justness of some e comparisons, appended a timely warning, in a valuable his comprehensive and excellent history of the *Marsu-* against the mistake to which the young zoologist might le, of concluding the analogical groups of the *Marsupialia acentalia* thus indicated to be of equal rank and value. I ways participated in this conviction of the lower value *Implacentalia* as compared with the *Placentalia;* and have ose terms merely as useful collective or general signs of modifications of structure, which are associated with the oment and non-development of the placenta.

ke manner, when indicating the highest generalization to I had arrived after comparisons of the dentition of the alia by the terms 'monophyodont' and 'diphyodont,'† ing respectively the single and double set of teeth devel- n different groups of the class, I have been careful to myself from being misunderstood, as supposing that the hyodont *Monotremata*, *Bruta*, and *Cetacea*, formed an lent group with the diphyodont bulk of the Mammalia, the binary groups, defined by this single dental character, atural ones.

ne Animal, ed. 1829, vol. i, p. 174.
ural History of the Mammalia, 8vo, 1845, part i, p. 14. I must remark, that in stating "by Prof. Owen and some other naturalists, the present sec- *rsupiata*) is ranked as a subclass," the reader, from the peculiarly extended ion given to the term 'Marsupiata,' might be misled. The *Marsupialia* of the orders of my subclass *Implacentalia*. See the articles 'Marsupialia' notremata,' in the "Cyclopædia of Anatomy," vol. iii, 1841.
lopædia of Anatomy, part xxxvii, 1849. Phil. Trans. 1850, p. 493.

Nothing more than a passing allusion seems needed to the system of classifying the Mammalia on the modifications of the placenta, originally proposed by Sir Everard Home,* and since reproduced and modified by a few other naturalists. The group, *e. g.* associated by the character of the discoid placenta, is as little natural as that which would be composed on the basis of the diphyodont dentition, or the unguiculate feet. The association of the *Rodentia*, and *Insectivora*, with the *Quadrumana*, as in the latest modification of the placentary system,† is not likely to command acceptance. The diffused placenta, as in the Mare, Porpoise, Peccari, Rhinoceros, and Camel, would lead to an equally heterogeneous assemblage. In two well-defined minor groups, *e. g.* the true *Carnivora* and the true *Ruminantia*, there exist characteristic modifications of the placenta, viz. the zonular and cotyledonal respectively; but though the zonular type is common to the *Carnivora*, it is not peculiar to them; it is that of the placenta in the Hyrax and the Elephant, amongst the *Ungulata*. So likewise the cotyledonal type characterizes the placenta of the Sloth among the *Bruta*.

(*To be continued.*)

ART. III.—*On the Rational Constitution of certain Organic Compounds*; by WOLCOTT GIBBS, M.D., Professor of Chemistry and Physics in the Free Academy in New York.

IN the following memoir I shall endeavor to establish the rational constitution of several important organic bodies by referring them to the type of one or more equivalents of water, in which hydrogen is wholly or partially replaced by compound radicals. The premises are as follows.

1. The electro-negative or chlorous hydrocarbons, formyl, C_2H, acetyl, C_4H_3, and their homologues, may replace hydrogen equivalent for equivalent, but by such replacement diminish the electro-positive or zincous character of the primitive. These facts are well exhibited in the acetyl-ammonia of Natanson, the formula of which is

$$N\left\{\begin{matrix}C_4H_3\\H\\H\end{matrix}\right\}.$$

2. The radicals formoxyl, C_2HO_2, acetoxyl, $C_4H_3O_2$, and their homologues and analogues, similarly replace hydrogen, and yield more electro-negative or chlorous derivatives. Thus acetamin has the formula

$$N\left\{\begin{matrix}C_4H_3O_2\\H\\H\end{matrix}\right.,$$

* Lectures on Comparative Anatomy, vol. iii, 4to, p. 445.

† GERVAIS, Zoologie et Paléontologie Française, 4to, 1853, p. 194.

le acetic acid is referable to the type of two equivalents of
er, and has the formula

$$\left.\begin{matrix}C_4H_3O_2\\ H\end{matrix}\right\}O_2.$$

. One equivalent of *any* ammonium may replace one equiva-
of hydrogen. Thus the formula of the hydrate of the
d of the primitive ammonium, NH_4O+HO, is also referable
he type of two equivalents of water, and we have for it the
ression

$$\left.\begin{matrix}NH_4\\ H\end{matrix}\right\}O_2.$$

. Certain radicals, whether divisible or indivisible, are binary
ernary in character, and replace two or three equivalents of
rogen. Thus the radicals C_2O_2, C_4O_4, and S_2O_4 are binary
le nitrogen, phosphorus, &c. are ternary. These premises,
very chemist knows, are not new. I formulate them for
venience of reference, and to save repetition.

propose now to apply these principles to certain bodies to
ch they have not hitherto been extended, and will consider
compounds in question *seriatim*.

Ilycocoll or glycosin.—The empirical formula of glycosin was
t definitely established by Horsford* in an elaborate memoir
which I shall frequently have occasion to refer. Of its ra-
al constitution no satisfactory theory has been proposed. I
r it to the type of hydrate of oxyd of ammonium, and con-
er it to have the formula

$$N\left\{\begin{matrix}C_2HO_2\\ C_2H\\ H\\ H\end{matrix}\right\}O+HO=C_4H_5NO_4.$$

is view of course (3) ultimately reduces glycosin to the type
two equivalents of water, $\left.\begin{matrix}H\\ H\end{matrix}\right\}O_2$. Glycosin, as is well known,
nbines with acids, bases, and salts. Its feebly acid character
explained, upon my view, by the presence of the two chlorous
icals; its basic properties, by the existence of two equivalents
hydrogen in the ammonium molecule; while its neutral char-
er—which resembles that of water—may be explained by
posing that the chemical sum of the chlorous and zincous
nities in the ammonium approaches the character of an equiv-
nt of hydrogen, so that we have the *functional* equation (*nearly*
e),

$$N\left\{\begin{matrix}C_2HO_2\\ C_2H\\ H\\ H\end{matrix}\right\}=H.$$

* Ann. der Chemie und Pharmacie, lx, 1.

The formulas of the principal salts of glycosin upon this theory are as follows.

Chlorhydrate,	$N(C_2HO_2.C_2H.H_2)Cl+2HO$.
Nitrate,	$\left.\begin{matrix}N(C_2HO_2.C_2H.H_2)\\NO_4\end{matrix}\right\}O_2+2HO$.
Sulphate,	$\left.\begin{matrix}N_2(C_2HO_2.C_2H.H_2)_2\\S_2O_4\end{matrix}\right\}O_4+2HO$.
Potash-sulphate,	$\left.\begin{matrix}N_2(C_2HO_2.C_2H.HK)_2\\S_2O_4\end{matrix}\right\}O_4$. (?)
Potash-nitrate,	$\left.\begin{matrix}N(C_2HO_2.C_2H.HK)\\NO_4\end{matrix}\right\}O_2+HO$.
Glycosin-lead,	$\left.\begin{matrix}N(C_2HO_2.C_2H.H.Pb.)\\H\end{matrix}\right\}O_2+HO$.
Glycosin-copper,	$\left.\begin{matrix}N(C_2HO_2.C_2H.H.Cu)\\H\end{matrix}\right\}O_2+HO$.

The platinum salt of glycosin contains, according to Horsford's analysis, 33·2 per cent of platinum, and he considers it to be

$$C_4H_4NO_3.PCl_2,$$

which requires that percentage. But Cahours* assigns to this salt the formula

$$C_4H_5NO_4.HCl+PCl_2,$$

which, upon the view which I have proposed, becomes

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}Cl+PtCl_2+2HO.$$

The other salts of glycosin are easily formulated upon the ammonium theory, and do not require special notice. The combinations which glycosin forms with metallic oxyds are however of no small interest from the point of view suggested. Thus Boussingault found for the compound with oxyd of silver the formula

$$C_4H_4NO_3.AgO.$$

I believe that in this body silver simply replaces hydrogen, the true formula being

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\Ag\\H\end{matrix}\right\}O+HO,$$

and that the analogous bodies containing zinc, copper, lead, &c. have a similar constitution. This theory gives the simplest explanation of the formation and constitution of hippuric acid, and of the analogous acids which Cahours and other chemists have recently produced. Thus hippuric acid, as Dessaignes first showed, may be formed by the action of chlorid of benzoxyl upon glycosin-zinc, the reaction being explained by the equation

* Comptes Rendus, xliv, 569.

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\Zn\\H\end{matrix}\right\}O+HO+C_{14}H_5O_2.Cl=N\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O+HO+ZnCl.$$

Hippuric acid is consequently also the hydrate of an ammonium oxyd, a view which I shall develop more fully in another part of this paper. The cuminuric, anisuric and salicuric acids, which Cahours* has described, are formed in a similar manner, and must therefore have a similar constitution. By the action of the chlorids of acetoxyl $C_4H_3O_2.Cl$, butyroxyl $C_8H_7O_2.Cl$, &c., upon glycosin-zinc, similar acids must be produced, while it appears, to say the least, extremely probable, that the ethyl radicals, C_4H_5, &c. may also be made to replace an equivalent of hydrogen in glycosin, yielding bodies of an analogous acid and basic character. Thus by the action of iodid of ethyl upon glycosin-silver we should have

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\C_4H_5\\H\end{matrix}\right\}O+HO,$$

and it is of course possible that the last equivalent of hydrogen may be also replaced by an equivalent of a chlorous or zincous radical, as in the case of Hofmann's tetrammoniums.

The products of the decomposition of glycosin strongly support the view that this body contains the radicals formyl and formoxyl, as above assumed. Thus when fused with caustic potash, ammonia and hydrogen are evolved, while the fused mass contains cyanid of potassium and oxalate of potash. It is however well established that formic acid, $\left.\begin{matrix}C_2HO_2\\H\end{matrix}\right\}O_2$, under the same circumstances yields oxalic acid, and the facility with which formyl, C_2H, in contact with nitrogen or ammonia yields cyanogen, is also familiar to chemists With oxydizing agents glycosin yields carbonic and cyanhydric acids and water. This also is in exact accordance with the theory.

By the action of nitrous acid upon glycosin Socoloff and Strecker obtained a new acid which they termed glycolic acid, and which is homologous with lactic acid. The formula of this acid is $C_4H_4O_6$, and its formation is usually represented by the equation

$$C_4H_5NO_4+NO_3=2N+C_4H_4O_6+HO.$$

If we compare ammonia, NH_3, with three equivalents of water, we find that from the equation

$$NH_3=O_3H_3,$$

one equivalent of nitrogen may be considered as *formally* though not *functionally* replacing three equivalents of oxygen. Hence

* C. R., xliv, 567.

in the action of NO_3 upon oxyd of ammonium we may suppose that a species of *substitution* takes place, 3O replacing N, while, as in ordinary cases of substitution, a double molecule NN is separated. Thus the action of NO_3 upon oxyd of ammonium, considered for the sake of simplicity as anhydrous, may be represented by the equation

$$N\left\{\begin{matrix}H\\H\\H\\H\end{matrix}\right\}O+NO_3=O_3\left\{\begin{matrix}H\\H\\H\\H\end{matrix}\right\}O+2N=\left.\begin{matrix}H\\H\\H\\H\end{matrix}\right\}O_4+2N.$$

When the oxyd of the ammonium is a monohydrate an equivalent of water is usually set free. This mode of considering the action of NO_3 upon ammonium molecules possesses advantages sufficient, as I think, to justify its employment. The formation of glycolic acid from glycosin may then be represented by the equation

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}O+HO+NO_3=O_3\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}O+2N+HO.$$

Glycolic acid has therefore the rational formula

$$\left.\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}O_4,$$

and is referable to the type of four equivalents of water, though with the atomic weight here assigned to it, it contains but one equivalent of hydrogen replaceable by a metal. From this it appears that in the action of NO_3 upon an ammonium, the four radical molecules of the ammonium pass unchanged into the acid, and that an equivalent of water is separated as such when NO_3 acts upon the hydrate of an ammonium-oxyd. It must be observed however that, in most cases at least, it is only the last molecule of hydrogen which is replaceable in the new acid by a metal, this being the hydrogen molecule originally contained in the atom of water which united with the ammonia to form oxyd of ammonium, according to the equation

$$N\left\{\begin{matrix}X\\Y\\Z\end{matrix}\right.+HO=N\left\{\begin{matrix}X\\Y\\Z\\H\end{matrix}\right\}O.$$

Strecker has shown that the action of NO_3 upon hippuric acid produces a new acid which he terms benzoglycolic acid. The rational constitution of this acid must be represented by the formula

$$\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O_4=C_{18}H_8O_8,$$

and I shall endeavor to show, farther on, that there are other reasons for taking this view. Strecker's elaborate study of the bile has shown that cholic and hyocholic acid may each, like hippuric acid, be split into glycosin and a new acid. I apply to both these acids the theory which I have above developed, and consider them rationally represented as follows,

$$\text{Cholic acid,}\quad N\left\{\begin{matrix} C_2HO_2 \\ C_2H \\ C_{48}H_{39}O_3 \\ H \end{matrix}\right\} O+HO=C_{52}H_{43}NO_{12}.$$

$$\text{Hyocholic acid,}\quad N\left\{\begin{matrix} C_2HO_2 \\ C_2H \\ C_{50}H_{41}O_3 \\ H \end{matrix}\right\} O+HO=C_{54}H_{45}NO_{12}.$$

That there are homologous compound molecules having the formulas $C_{48}H_{39}O_8$ and $C_{50}H_{41}O_8$, is shown by the existence of cholalic and hyocholalic acids, the empirical formulas of which are $C_{48}H_{40}O_{10}$ and $C_{50}H_{42}O_{10}$, and which when reduced to the type of two equivalents of water become

$$\left.\begin{matrix} C_{48}H_{39}O_3 \\ H \end{matrix}\right\} O_2 \quad \text{and} \quad \left.\begin{matrix} C_{50}H_{41}O_3 \\ H \end{matrix}\right\} O_2.$$

I may here remark that by the action of NO_3 upon cholic and hyocholic acids we ought to obtain two new acids having the formulas

$$\left\{\begin{matrix} C_2HO_2 \\ C\ H \\ C_{48}H_{39}O_8 \\ H \end{matrix}\right\} O_4=C_{52}H_{42}O_{14},\ \text{and}\ \left\{\begin{matrix} C_2HO_2 \\ C_4H \\ C_{50}H_{41}O_3 \\ H \end{matrix}\right\} O_4=C_{54}H_{44}O_{14}.$$

I may further remark, in this connection, that we ought to be able to regenerate cholic and hyocholic acids from glycosin and cholalic and hyocholalic acids, by processes exactly analogous to that employed by Dessaignes in preparing hippuric acid. Thus cholalic acid by distillation with perchlorid of phosphorus should give chlorhydric acid and chlorid of cholalyl, according to the equation

$$C_{48}H_{40}O_{10}+PCl_5=C_{48}H_{39}O_3.Cl+PO_2Cl_3+HCl,$$

and chlorid of cholalyl with glycosin-silver should yield cholic acid and chlorid of silver. As cholalic and hyocholalic acids are homologous and have very high equivalents, it is almost certain that they are among the upper members of a complete series. Of this series chinovic acid, $C_{38}H_{30}O_{10}$, is probably a member.

Hippuric acid.—The formation of this acid by the action of chlorid of benzoxyl upon glycosin-zinc has already been explained upon the ammonium theory as a simple substitution of the radical $C_{14}H_5O_2$ for an equivalent of hydrogen. It remains to show upon the same theory that the separation of hippuric acid into glycosin and benzoic acid may be equally well ac-

counted for. The following equation appears to contain a si ple solution of the question, since we have

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O+2HO=N\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}O+C_{14}H_6O_4,$$

the glycosin-ammonium of course uniting at the moment of formation with an equivalent of water. By this view of t constitution of hippuric and other similar acids, we explain once its formation, its decomposition by boiling with acids, a its unibasic character, since its molecule contains only one equ alent of hydrogen replaceable by a metal. But the products the decomposition of the acid by other agents also confirm t view here taken.

By boiling with peroxyd of lead, hippuric acid yields ben: mid and carbonic acid, while with peroxyd of manganese a sulphuric acid, benzoic acid, carbonic acid, and sulphate of a monia are formed. These reactions are expressed by the eq tions

$$N\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O+6O=N\left\{\begin{matrix}H\\H\\C_{14}H_5O_2\end{matrix}\right\}+2C_2O_4+HO,$$

and $$N\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O+HO+6O+SO_3.HO=NH_4O.SO_3+C_{14}H_6O_2+4C$$

In both these cases the easily oxydized radicals, formyl a formoxyl, are destroyed, yielding carbonic acid and water, wh in both the radical $C_{14}H_5O_2$ is found unchanged among t products of decomposition.

As glycosin by the action of NO_3 yields glycolic acid, so h puric acid under the same circumstances yields benzoglyco acid, thus we have for the derived acids

$$\text{Glycolic acid}\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}O_4,\qquad \text{Benzoglycolic acid}\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O_4.$$

By boiling an aqueous solution of benzoglycolic acid, it is : solved into glycolic and benzoic acids, the reaction being

$$\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}O_4+2HO=\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}O_4+\left.\begin{matrix}C_{14}H_5O_2\\H\end{matrix}\right\}O_2.$$

Now this decomposition is precisely analogous to the resoluti of hippuric acid into glycosin and benzoic acid, explained the equation

$$\left\{\begin{matrix}C_2HO_2\\C_2H\\C_{14}H_5O_2\\H\end{matrix}\right\}NO+2HO=\left\{\begin{matrix}C_2HO_2\\C_2H\\H\\H\end{matrix}\right\}NO+\left.\begin{matrix}C_{14}H_5O_2\\H\end{matrix}\right\}O_2.$$

I bring forward these two parallel cases I believe for the first time. They are types of a great number of similar decompositions, and as I think, justify my two assumptions, first, that *one* equivalent of nitrogen *formally* replaces *three* equivalents of oxygen, or what is the same thing that $NO=O_4$, and second, *that for every ammonium-oxyd, or its hydrate, there is an acid or anhydrid corresponding to four equivalents of water, and in which the four radicals which replace the four equivalents of hydrogen are the same as the four in the original ammonium.* I believe that this principle will prove extremely fertile both in explanations and in new facts. I shall endeavor to develop this view more fully when speaking of other compound ammoniums.

In a note to the article Hippuric acid in the 3d volume of his Traité de Chimie Organique, p. 241, Gerhardt has suggested that hippuric acid, as well as glycosin, may be referred to the type of a hydruret of ammonium,

$$\left.\begin{matrix}NH_4\\H\end{matrix}\right\}=\left.\begin{matrix}H\\H\end{matrix}\right\}.$$

Upon this view, which is thrown out merely as a suggestion, Gerhardt represents glycosin as

$$\left.\begin{matrix}NH_2.(C_2HO_2)_2\\H\end{matrix}\right\}$$

and hippuric acid as

$$\left.\begin{matrix}NH.(C_2HO_2)_2C_{14}H_5O_2\\H\end{matrix}\right\}.$$

Strecker considers glycosin as possibly an ammonia having the formula

$$N\left\{\begin{matrix}C_4H_3O_4\\H\\H\end{matrix}\right\}$$

To this theory it may be objected that it does not explain the formation of alanin and other bodies of the same class, or the products of their decomposition.

Laurent looked upon glycosin either as amido-acetic acid—a view also recently taken by Cahours—or as the acid amid of glycolic acid. But Dessaignes has actually prepared glycolamid, and has shown that it is only isomeric and not identical with glycosin.

Alanin.—This body was obtained by Strecker by evaporating a mixture of aldehyd-ammonia and cyanhydric acid with chlorhydric acid, and its empirical formula is $C_6H_7NO_4$, so that it is homologous with glycosin. Its mode of formation appears to me to show in the clearest manner its molecular structure, and I consider it to have the rational formula

$$N\left\{\begin{matrix}C_4H_3O_2\\C_2H\\H\\H\end{matrix}\right\}O+HO.$$

If this view be correct we ought to find the radical C_4H among the products of the decomposition of alanin. In] of fact, when heated with peroxyd of lead it yields aldehyd, monia and carbonic acid, the carbon of the radical formyl alone being oxydized. With nitrous acid alanin yields l acid, the formula of which is thus found to be

$$\left.\begin{matrix} C_4H_3O_2 \\ C_2H \\ H \\ H \end{matrix}\right\} O_4.$$

Now lactic acid, when heated with sulphuric acid and per(of manganese, yields carbonic acid and an abundance of alde as Städeler has shown. Both the mode of formation and products of decomposition of alanin support the view tak(its composition. But we may I think go farther. There a least *three* bodies having the empirical formula $C_6H_7NO_4$; are alanin, sarkosin, and lactamid. As sarkosin perfectl' sembles alanin and glycosin in properties it must belong t(same series of bodies. I suggest that its rational formula ma

$$N\left\{\begin{matrix} C_2HO_2 \\ C_4H_3 \\ H \\ H \end{matrix}\right\} O+HO.$$

In this case it should give with nitrous acid a species of l acid isomeric with that derived from alanin and having formula

$$\left.\begin{matrix} C_2HO_2 \\ C_4H_3 \\ H \\ H \end{matrix}\right\} O_4.$$

There are however, as is well known, *two* lactic acids, the fo derived from alanin by the action of nitrous acid, as well as : sugar by the lactic fermentation; while the other exists in juice of flesh with sarkosin itself. It is proper to remark one of the two equivalents of hydrogen in the above form appears, so far at least as our knowledge goes, not to be rep able by a metal, so that lactic acid, like glycolic acid, is m basic. On the other hand, as in the case of benzogly acid, we have an acid in which this equivalent of hydrog replaced by an equivalent of benzoxyl. The primitive of acid must be an acid hydrate of ammonium-oxyd homolo with hippuric acid. Thus we have, uniting the formulas in gle lines to save space,

$$\left.\begin{matrix} N\{C_4H_3O_2.C_2H_3.C_{14}H_5O_2.H\} \\ H \end{matrix}\right\} O_2 \quad \text{Alanin-hippuric acid.}$$

$$C_4H_3O_2.C_2H.C_{14}H_5O_2.H\} O_4 \quad \text{Benzolactic acid.}$$

is clear that alanin, sarcosin and their homologues will yield ι indefinitely great number of new acids, of which one series ill contain nitrogen, the other not.

The almost perfect analogy between alanin and glycosin justi-s the inference that the internal molecular structure of these ro bodies is the same. The formula of alanin which is assumed ove is deduced from its mode of formation, and that of glyco-ı is based upon the assumption that this body may be formed a similar manner, namely, by digesting together the aldehyd-nmonia of formic acid, $C_2HO_2.NH_3$, and cyanhydric acid. his theory cannot at present be put to the test of experiment cause the formic aldehyd, $C_2HO_2.H$, has not yet been ob-ined. Another difficulty however arises. The formula of anin assumed above supposes that formyl, C_2H, and acetoxyl, $_4H_3O_2$, enter into the ammonium *as such*, each radical replac-ıg an equivalent of hydrogen. It is however possible that ese two radicals are in alanin so fused together as to constitute single di-atomic radical, $C_6H_4O_2$, homologous with the glycolic dical, $C_4H_2O_2$. In this case the formulas of glycosin and lanin will be

$$\text{Glycosin,}\qquad N\left\{\begin{matrix}C_4H_2O_2\\ H_2\end{matrix}\right\}O+HO.$$

$$\text{Alanin,}\qquad N\left\{\begin{matrix}C_6H_4O_2\\ H_2\end{matrix}\right\}O+HO.$$

Ipon this view the rational formulas of glycolic and lactic acids ecome

$$\left.\begin{matrix}C_4H_2O_2\\ H_2\end{matrix}\right\}O_4 \quad\text{and}\quad \left.\begin{matrix}C_6H_4O_2\\ H_2\end{matrix}\right\}O_4.$$

The decision of the question obviously turns upon the molecular tructure of the radical $C_4H_2O_2$. Is this diatomic and indivisible, r is it a conjugate radical $C_2H.C_2HO_2$? On the other hand t appears possible that there may be two species of glycosin, of hich the one contains formyl and formoxyl, the other the radi-al $C_4H_2O_2$. The rational formulas which I have assigned to lycosin and alanin appear, in the present state of our knowl-dge, most consistent with observed facts.

Leucin.—The formula of leucin upon my view becomes

$$N\left\{\begin{matrix}C_{10}H_9O_2\\ C_2H\\ H\\ H\end{matrix}\right\}O+HO,$$

nd the products of its decomposition bear out the theory com-pletely. Limpricht* has prepared leucin from valeric aldehyd by a process exactly similar to that employed by Strecker in the formation of alanin. From this it follows that leucin is consti-uted, so far as the character of the radicals is concerned, like

* Ann. der Chemie und Pharmacie, xciv, 248.

alanin and not like sarcosin. It appears, however, probable that there exists another species of leucin having the formula,

$$N\left\{\begin{matrix}C_2HO_2\\ C_{10}H_9\\ H\\ H\end{matrix}\right\}O+HO.$$

But the high equivalent of leucin points out to us the possible existence of three other bodies of a perfectly analogous structure and isomeric with ordinary leucin. Thus we have

$$N\left\{\begin{matrix}C_6H_5O_2\\ C_6H_5\\ H\\ H\end{matrix}\right\}O+HO,\quad N\left\{\begin{matrix}C_8H_7O_2\\ C_4H_3\\ H\\ H\end{matrix}\right\}O+HO,\quad \text{and } N\left\{\begin{matrix}C_4H_3O_2\\ C_8H_7\\ H\\ H\end{matrix}\right\}O+HO.$$

Each one of these five species of leucin must yield a homologue of lactic acid, the only one yet discovered being the leucic acid of Strecker, which belongs to the series of the lactic acid of fermented sugar, and is derived from leucin by the action of nitrous acid.

It is easy to see that the homologues of glycosin, as we ascend in the series, for the same empirical constitution in the case of each one, must become more and numerous, and the same is consequently true for the homologues of glycolic acid.

Tyrosin.—The empirical formula of tyrosin, according to the analyses of Hinterberger, is $C_{18}H_{11}NO_6$. As the properties of this body are perfectly analogous to those of the members of the glycosin series, it may also be reduced to the same type, in which case its rational constition may perhaps be represented by the formula,

$$N\left\{\begin{matrix}C_{14}H_5O_2\\ C_4H_3O_2\\ H\\ H\end{matrix}\right\}O+HO,$$

In nitrotyrosin we may suppose one of the two equivalents of hydrogen in the compound ammonium to be replaced by NO_4. The products of the decomposition of tyrosin have not however been studied sufficiently to enable us to assign its rational formula with any degree of certainty, and it is clear that the ammonium molecule assumed may be constituted in several different ways, so as to give the same empirical formula. Thus Wicke* suggests that tyrosin may be formed from anisic aldehyd and cyanhydric acid, as alanin is formed from acetic aldehyd. In this case the rational formula would be

$$N\left\{\begin{matrix}C_{16}H_8O_4\\ C_2H\\ H\end{matrix}\right\}O+HO,$$

it being remembered that $C_{16}H_8O_4$ has the value of two equivalents of hydrogen. Farther researches are required to settle this question.

* Ann. der Chemie und Pharmacie, ci, 314.

Anthranilic acid.—Kubel* has recently shown that anthranilic acid plays the part of a weak base with acids, yielding well defined salts with nitric, sulphuric and oxalic acids. The products of its decomposition by heat, viz., anilin and carbonic acid, are similar to those of leucin, which, according to Limpricht,† under the same circumstances yields amylamin and carbonic acid, the equations being

$$C_{12}H_{13}NO_4 = C_2O_4 + C_{10}H_{13}N,$$
$$C_{14}H_7NO_4 = C_2O_4 + C_{12}H_7N.$$

It is therefore probable that anthranilic acid belongs to the same type as leucin. Schwanert‡ adopts this view, and considering anthranilic acid as carbanilic acid, regards leucin as amyl-carbamic acid, a view which explains only one of the modes of decomposition of that body, and which is irreconcilable with all the rest. I suggest that anthranilic acid may contain the salicyl radical, $C_{14}H_4O_2$, and that its rational formula is

$$N\left\{\begin{matrix}C_{14}H_4O_2\\H\\H\end{matrix}\right\}O+HO.$$

In the decomposition of anthranilic acid by heat, all the oxygen unites with two equivalents of the carbon of the salisoxyl, $C_{14}H_4O_2$, while all the hydrogen remains united with the other twelve equivalents of carbon and one of nitrogen to form anilin. The radical $C_{14}H_4O_2$ is of course to be regarded as diatomic. That anthranilic acid actually contains the radical $C_{14}H_4O_2$ appears most clearly from the fact that with nitrous acid it yields salicylic acid, by the process of replacement already explained. Thus we have

$$\left\{\begin{matrix}C_{14}H_4O_2\\H\\H\end{matrix}\right\}NO+HO+NO_3=\left\{\begin{matrix}C_{14}H_4O_2\\H\\H\end{matrix}\right\}O_4+2N+HO.$$

Taurin.—This substance may be readily reduced to the type of hydrate of oxyd of ammonium, if we remark that the radical S_2O_4 replaces two equivalents of hydrogen. We have then for taurin the formula

$$N\left\{\begin{matrix}S_2O_4\\C_4H_5\\H\end{matrix}\right\}O+HO.$$

By fusion with caustic potash taurin yields acetate and sulphite of potash, a result which is easily explained upon the supposition that the ammonium molecule contains ethyl. By the action of nitrous acid taurin should yield an acid having the formula $C_4H_6S_2O_8$, since we should have the equation

$$N\left\{\begin{matrix}S_2O_4\\C_4H_5\\H\end{matrix}\right\}O+HO+NO_3=\left\{\begin{matrix}S_2O_4\\C_4H_5\\H\end{matrix}\right\}O_4+2N+HO.$$

* Ann. der Chemie und Pharmacie, cii, 236. † The same, ci, 295.
‡ Ann. der Chemie und Pharmacie, cii, 221.

The experiment has not to my knowledge been tried,* Strecker's discovery that isethionate of ammonium by lo two equivalents of water is converted into taurin leaves l doubt that taurin is the ammonium of isethionic acid, and the latter acid is to be referred to the type of four equivalent water. Strecker's reaction is indicated by the rational equa

$$\left.\begin{matrix} S_2O_4 \\ C_4H_5 \\ NH_4 \end{matrix}\right\} O_4 - 2HO = \left\{\begin{matrix} S_2O_4 \\ C_4H_5 \\ H \end{matrix}\right\} NO + HO.$$

Choleic acid may be regarded as taurin in which an equiva of hydrogen in the ammonium is replaced by an equivalen the radical of cholalic acid. Its formula upon this view is

$$N\left\{\begin{matrix} S_2O_4 \\ C_4H_5 \\ C_{48}H_{39}O_8 \end{matrix}\right\} O + HO,$$

It must be remarked however that this formula contains equivalent of water less than that deduced by Strecker from analyses. Assuming it to be correct, it shows that there ex the same relation between taurin and choleic acid as betw glycosin and cholic acid. It would be interesting, from a pl iological as well as from a chemical point of view, to determ by experiment whether cholalic acid taken into the stom would be found in the urine in the form of cholic acid, a re which might be expected from well known facts in relatio the conversion of benzoic into hippuric acid under the same cumstances. Should this result be obtained it would show t the kidneys are capable of producing under certain circumsta a true biliary secretion.

Asparagin.—The formula of this body may be reduced to type of two equivalents of oxyd of ammonium, but the data determining the particular character of the radicals repla hydrogen are not at present sufficient. I shall therefore con myself with suggesting that asparagin may have the formula

$$\left.\begin{matrix} N\{C_2HO_2.C_2H.H_2\} \\ N\{C_2HO_2.C_2H.H_2\} \end{matrix}\right\} O_2,$$

in which case its relations to glycosin are obvious. It may be referred to the same type by supposing that it contains oxal, the formula being then

$$\left.\begin{matrix} N\{C_4H_2O_2.H_2\} \\ N\{C_4H_2O_2.H_2\} \end{matrix}\right\} O_2.$$

These views will be discussed more fully in speaking of m acid.

* Since the above was written, I have made the experiment in question and complete success, obtaining isethionate of potash by the action of nitrite of pc upon taurin dissolved in dilute nitric acid.—W. G.

In concluding the first section of this paper, which embraces only nitrogenous compounds performing at the same time the functions of acids and bases, I shall venture to suggest that the nitrogenous animal and vegetable substances, known as proteine bodies, belong to the same class as glycosin, leucin, &c. As the equivalents of these bodies are high, and as they contain more than one equivalent of nitrogen, they may perhaps be referred to the type of two or four equivalents of oxyd of ammonium or its hydrate. Another view which may be taken is that they contain, as substitutes for hydrogen, amids of the type $N \left\{ \begin{matrix} H \\ H \end{matrix} \right\}$, each such amid replacing a single equivalent of hydrogen. In this manner they may possibly be reduced to the type of one equivalent of oxyd of ammonium. Thus a body containing four equivalents of nitrogen may be represented by the formula

$$N \left\{ \begin{matrix} NX_2 \\ NY_2 \\ NZ_2 \\ V \end{matrix} \right\} O+HO.$$

It is well known that the so-called proteine bodies are generally soluble both in acids and alkalies. By the action of oxydizing agents they yield, as first products of their decomposition, various nitriles, valeronitril, benzonitril, &c., in this respect exactly resembling glycosin, leucin, &c. Setting out from this view I have examined the action of nitrous acid upon gelatin, casein, and albumin, and have found that this agent exerts a more or less powerful action upon each of these bodies. A solution of gelatin, for example, is decomposed by a current of NO_3 with strong effervescence, while an acid liquid remains, the examination of which is not yet complete. In the present imperfect state of our knowledge of the products of the oxydation of gelatin and the proteine bodies, it appears almost hopeless to attempt to represent them by formulas, even if we neglect the small quantities of sulphur and phosphorus which they always contain. To illustrate my suggestion as to their constitution, however, I will give a formula for albumen which will represent tolerably well the products of its decomposition and serve to exhibit the type to which it perhaps belongs. The analyses of albumen of white of eggs are nearly represented by the empirical formula*

$$C_{32}H_{24}N_4O_{10}.$$

* Scheerer found

			Theory.
	Carbon,	54·3	54·5
	Hydrogen,	7·1	6·8
	Nitrogen,	15·7	15·9
	Oxygen,	—	22·7
			100·00

Upon the view above taken that albumen is reducible to the type of hydrate of oxyd of ammonium in which hydrogen is partially replaced by certain amids, we may assign to it the formula

$$N\left\{\begin{matrix} N.H.C_{14}H_5O_2 \\ N.H.C_{12}H_{11}O_2 \\ N.H.C_4H_3O_2 \\ C_2HO_2 \end{matrix}\right\}O+HO=C_{32}H_{24}N_4O_{10}.$$

I again observe that I bring forward this formula simply as an illustration of a particular view, and not as a definite expression for the constitution of albumen. Speculations of this kind are not without value, since it is, to say the least, possible that all the *crystalline* nitrogenous vegetable and animal products are reducible to the same general type of two or more equivalents of water in which hydrogen is more or less completely replaced by complex ammonium molecules. I will even venture to hazard the suggestion that the entire vegetable or animal organism may be reduced to the water type, since resins, essential oils, and other bodies belonging to the type of hydrogen, are either secretions or excretions, and do not form a part of the organism itself. One of the problems of physiology must then be to reduce all parts of the organism to the least possible number of water types, and to show how each constituent may be derived from water by perfectly definite and uniform processes of substitution.

In considering the action of nitrous acid upon the ammoniums or their hydrates, I have endeavored to show that the action may be regarded as a regular process of substitution in which one equivalent of nitrogen replaces three equivalents of oxygen. The cases which I have mentioned are by no means the only ones which illustrate this species of replacement, since it may be used to explain the action of ammonia upon a great number of organic compounds. Thus hydrobenzamid results from the action of ammonia upon oil of bitter almonds according to the equation,

$$3C_{14}H_6O_2+2NH_3=C_{42}H_{18}N_2+6HO.$$

We may here suppose O_6 to be simply replaced by N_2, since we have a binary substituting molecule, namely, $N_2|H_6$, acting upon the six equivalents of oxygen, one-half of the binary molecule taking the place of the oxygen displaced. If we admit that oxygen and nitrogen replace each other in the manner supposed, we may reduce a great number of nitrogenous compounds directly to the same type without the intervention of any *special* theory whatever. Thus $C_{42}H_{18}N_2$ and $C_{42}H_{18}O_6$ would belong to the same type. Substitutions of oxygen for nitrogen sometimes occur, as in the conversion of acetonitril into acetic acid, since we have

$$C_4H_3N+3HO=C_4H_3O_3+NH_3.$$

§ 2.

'he views above developed have led me to the consideration of rational constitution of certain organic acids, some of which e been already mentioned. In endeavoring to establish the nulas of these acids I set out from the principle that the type the acid is to be deduced from its mode of formation, and n the products of its decomposition, and not merely from the nber of equivalents of replaceable hydrogen which it con- is. Thus the empirical formula of lactic acid is $C_6H_6O_6$, and he acid with this formula is monobasic, it is usually reduced he type of two equivalents of water,

$$\left.\begin{matrix} C_6H_5O_4 \\ H \end{matrix}\right\} O_2,$$

compound $C_6H_5O_4$ being considered as having the value one equivalent of hydrogen.

. have endeavored to show that, inasmuch as lactic acid is de- ed from alanin by the replacement of O_3 by N, and separa- 1 of an equivalent of water, the true type is that of *four* uivalents of water, the rational formula being

$$\left.\begin{matrix} C_4H_3O_2 \\ C_2H \\ H \\ H \end{matrix}\right\} O_4,$$

l upon this view I have endeavored to explain the difference ween the lactic acid derived from flesh and that formed in the mentation of sugar, this difference being explained not by the umption of two isomeric radicals, $C_6H_5O_4$, but by an actual ference in the structure of the acid. I have suggested also t there may be a species of glycosin having the formula

$$N\left\{\begin{matrix} C_4H_2O_2 \\ H_2 \end{matrix}\right\} O+HO.$$

this case there must also be a body isomeric with alanin, and ring the formula

$$N\left\{\begin{matrix} C_6H_4O_2 \\ H_2 \end{matrix}\right\} O+HO,$$

pposing of course that the two radicals which I have assumed alanin, namely, $C_4H_3O_2$ and C_2H, are not fused together to m $C_6H_4O_2$, but exist separately. Such a body would give a tic acid having the rational formula

$$\left.\begin{matrix} C_6H_4O_2 \\ H_2 \end{matrix}\right\} O+HO.$$

In what precedes I have assumed that lactic acid is monobasic, hile it is more usual to double its formula and consider it as basic. It must however be remembered that, according to recker's observations, the density of the vapor of lactate of hyl corresponds to four volumes only upon the supposition at the acid is monobasic. The rational formula above pro-

posed contains *two* equivalents of free hydrogen, and it would therefore appear that lactic acid, even upon my view, should be bibasic. I have already stated that—as an empirical result—when an acid belonging to the type of *four* equivalents of water is derived from an ammonium or its hydrated oxyd, it is only the last equivalent of hydrogen which is replaceable by another radical to form a salt. There must be a reason for this, and perhaps either or both of the following may be satisfactory.

In the first place it appears probable that in all the salts of ammonium the *fourth* equivalent of hydrogen is differently combined from the other three, and if this view be correct it is reasonable to suppose that this peculiarity will exist also in the acids which are derived from ammoniums. Again it may be that in glycosin, alanin, &c., and therefore in the acids derived from them, the two molecules constituting the aldehyds from which these bodies are derived, enter *in connection* and not separately, as I have all along represented them in the present paper. Thus alanin may be

$$N\left\{\begin{matrix} C_4H_3O_2.H \\ C_2H \\ H \end{matrix}\right\}O+HO.$$

In which case the lactic acid derived from it will be

$$\left.\begin{matrix} C_4H_3O_2.H \\ C_2H \\ H \end{matrix}\right\}O_4,$$

and it is easy to see from this formula that there will be but one equivalent of replaceable hydrogen in the acid. This latter view is perhaps supported by the mode of formation of acetonic acid which Städeler obtained by digesting acetone with cyanhydric and chlorhydric acids, and which has the empirical formula $C_8H_8O_6$. Its rational formula upon the above view will be

$$\left.\begin{matrix} C_4H_3O_2.C_2H_3 \\ C_2H \\ H \end{matrix}\right\}O_4.$$

My reason for not adopting in the outset the slight modification of the rational formulas just proposed is to be found in the fact that in glycosin, alanin and their congeners one equivalent of hydrogen—the last but one—is replaceable by an equivalent of silver or another metal. If now we suppose that these bodies contain aldehyds, we must admit that it is in each case the hydrogen molecule of the aldehyd which is replaced by the metal, or that there are compounds like $C_4H_3O_2.Ag$, which is not supported by any experimental evidence. The point is after all of but little importance, and does not affect the theory in any essential particular. The so-called anhydrous lactic acid which has the empirical formula $C_6H_5O_5$ may be reduced—after doubling its equivalent—to the type of *six* equivalents of water, and will then have the rational formula

$$\left.\begin{matrix} C_4H_3O_2.H \\ C_2H \\ C_4H_3O_2.H \\ C_2H \end{matrix}\right\} O_6.$$

Lactid, $C_6H_4O_4$, may be reduced to the type of two equivalents of water, and is rationally

$$\left.\begin{matrix} C_4H_3O_2 \\ C_2H \end{matrix}\right\} O_2.$$

Lactamid which is isomeric with alanin appears to belong to the type of two equivalents of water since it yields lactic acid and ammonia by taking up two equivalents of water. It is however difficult in the present state of our knowledge to assign a rational formula for bodies of this class. The same remark applies to lactamic acid.

Malic acid.—Some idea of the rational constitution of malic acid may be obtained from an attentive consideration of the products of its decomposition. Caustic potash at a high temperature converts the acid into oxalic and acetic acids, two equivalents of oxygen being required for the oxydation, since we have the equation

$$C_8H_6O_{10}+2O=C_4H_4O_4+C_4H_2O_8.$$

Bromine decomposes the acid with formation of bromoform. According to Vauquelin, nitric acid converts it into oxalic acid. Sulphuric acid gently heated with the acid yields carbonic oxyd and, according to Liebig, acetic acid. Finally, a mixture of sulphuric acid and bichromate of potash converts all the carbon into carbonic acid. I refer malic acid to the type of six equivalents of water, and consider it to contain either formyl and formoxyl, or glyoxal and formyl, so that its rational formula will be either

$$(1.)\quad \left.\begin{matrix} C_4H_2O_4 \\ C_2H \\ C_2H \\ H_2 \end{matrix}\right\} O_6, \quad \text{or} \quad (2.)\quad \left.\begin{matrix} C_2HO_2 \\ C_2HO_2 \\ C_2H \\ C_2H \\ H_2 \end{matrix}\right\} O_6.$$

If we admit that two equivalents of formoxyl, C_2HO_2, may be so fused together as to form one equivalent of glyoxal, we may also suppose that two of formyl, C_2H, may unite to form one equivalent of a diatomic radical having the formula C_4H_2. In this case the rational formula of malic acid, still referred to the type of six equivalents of water, will be

$$(3.)\quad \left.\begin{matrix} C_4H_2O_4 \\ C_4H_2 \\ H_2 \end{matrix}\right\} O_6.$$

In his memoir on glyoxal and its derivatives, Debus has suggested that a relationship between glycolic, malic, citric, glyoxylic and tartaric acids, may be traced by means of glyoxal, without however attempting in this way to express the rational

constitution of these acids, or in fact anything more than their formation and modes of decomposition. Representing glyoxal $C_4H_2O_4$ by the symbol gly, we have for the acids in question the following scheme.

Glycolic acid,	gly. H_2O_2.	Glyoxylic acid,	gly. O_2.
Malic acid,	gly $_2$. H_2O_2.	Anhyd. tartaric acid,	gly $_2$. O_2.
Citric acid,	gly $_3$. H_2O_2.		

Debus shows further how citric, malic and glycolic acids by losing two equivalents of water form aconitic and maleic acids, and glyoxal. I am disposed to go much farther and represent the rational constitution of a number of organic acids by supposing them to contain glyoxal or diformoxyl, and formyl or diformyl. It appears to me that it may reasonably be doubted whether the glycolic acid obtained by the action of nitrous acid upon glycosin is identical with that which Debus obtained by boiling glyoxal with milk of lime. I mean of course here to assume that ordinary glycosin may be formed by digesting formic aldehyd, $C_2HO_2.H$, with cyanhydric and chlorhydric acids, so that its structure is similar to that of alanin. There may be more than one species of glycosin, one being for instance

$$\left.\begin{matrix} N.C_2HO_2.C_2H.H_2 \\ H \end{matrix}\right\} O_2,$$

while another is

$$\left.\begin{matrix} N.C_4H_2O_2.H_2 \\ H \end{matrix}\right\} O_2.$$

But bearing these distinctions in mind, I shall endeavor to give rational formulas for certain organic acids involving as few assumptions as possible, and connecting those which are not homologous. The formula (1.) which I have given for malic acid explains sufficiently well the products of its decomposition, since glyoxal by taking up two equivalents of hydrogen becomes acetic acid, while the oxydation of $C_4H_2O_4$ or of C_4H_2 will account for the formation of oxalic and carbonic acids. Maleic and fumaric acids have the formula $C_8H_6O_8$. If we suppose that the action of heat simply splits the equivalent of glyoxal in malic acid into two equivalents of formoxyl, C_2HO_2, and that one eq. of formoxyl loses two eq. of oxygen, the formula common to the two pyrogenic acids becomes

$$\left.\begin{matrix} C_2HO_2 \\ C_2H \\ C_2H \\ C_2H \\ H_2 \end{matrix}\right\} O_6 = C_8H_6O_8.$$

This formula gives no explanation of the difference between the two acids. It may be that, in one of these, two molecules of formyl, C_2H, are united to form a molecule of diformyl, C_4H_2, but further researches are necessary before any satisfactory explanation can be proposed.

The formulas which I have given for malic acid lead to the conclusion that asparagin, $C_8H_8N_2O_6$, is referable to the type of two equivalents of oxyd of ammonium, and it may have the rational formula

$$N_2\left\{\begin{matrix}C_4H_2O_4\\C_2H\\C_2H\\H_4\end{matrix}\right\}O_2.$$

By the action of nitrous acid asparagin becomes

$$\left.\begin{matrix}C_4H_2O_4\\C_2H\\C_2H\\H_4\end{matrix}\right\}O_8,$$

which immediately splits into one equivalent of malic acid and two of water. Aspartic acid may also be reduced to the type of six equivalents of water, if, as is certainly admissible, we suppose NH_2 to replace H, so that we have as the rational formula

$$\left.\begin{matrix}C_4H_2O_4\\C_2H\\C_2H\\NH_2\\H\end{matrix}\right\}O_6.$$

On the other hand this view does not account for the basic properties of aspartic acid which, as is well known, forms definite compounds with the stronger acids. We meet here with the same difficulty which occurs in formulating benzamic acid and many other similar bodies.

Tartaric acid.—The researches of Dessaignes have shown that glyoxal is a product of the oxydation of tartaric by nitric acid, and the facility with which oxydizing agents convert tartaric acid into formic and carbonic acids has long been known. By fusion with caustic potash tartaric acid yields acetic, oxalic, formic and carbonic acids as I have myself observed, while at the same time an inflammable gas burning with a yellow flame is given off: this gas appears to be only an impure hydrogen. If we regard tartaric acid as bibasic I suggest that its rational formula may be

$$\left.\begin{matrix}C_4H_2O_4\\C_2HO_2\\C_2H\\H_2\end{matrix}\right\}O_6,$$

which places its relation to malic acid in the clearest light, and at the same time accounts for the facility with which it is decomposed, and for the products of its decomposition. Our knowledge of the modes of decomposition of pyrouvic and pyrotartaric acids is not sufficiently complete to permit us to form any idea of their rational constitution.

Citric acid.—The combinations of citric acid with ethyl and methyl conclusively show that this acid is tribasic and that its

formula is $C_{12}H_8O_{14}$. Those chemists who have endeavored to reduce it to the type of water refer it to six equivalents and represent it by the formula

$$\left.\begin{matrix} C_{12}H_5O_8 \\ H_3 \end{matrix}\right\} O_6.$$

I suggest that it may be referred to the type of eight equivalents of water and that its rational formula is

$$\left.\begin{matrix} C_4H_3O_2 \\ C_4O_4 \\ C_2H \\ C_2H \\ H_3 \end{matrix}\right\} O_8,$$

so that it contains the radicals of acetic and oxalic acids together with two equivalents of formyl. The view here taken of the rational constitution of citric acid appears to be supported by the character of the products of its oxydation. Thus, according to Gay-Lussac, citric acid fused with caustic potash yields a mixture of acetate and oxalate of potash. Concentrated sulphuric acid disengages pure carbonic oxyd almost without the aid of heat. Peroxyd of manganese and sulphuric acid transform citric into formic and carbonic acids. Finally, concentrated nitric acid oxydizes citric acid to a mixture of oxalic and acetic acids, while carbonic acid is evolved. All these reactions are easily and simply explained upon the hypothesis that citric acid contains within its molecule the radicals above mentioned. The products of the decomposition of the acids derived from citric acid by heat have not yet been studied, and it is therefore useless to endeavor to assign to these acids rational formulas. It seems moreover probable that there is no connection between the radicals in the primitive acid and in its pyrogenic derivatives, since the action of heat may be reasonably supposed to break up the radicals of the primitives and unite their constituents in entirely different proportions. The same remark applies to powerful agents, like chlorine and bromine, which generate at the same time products of oxydation and of substitution.

Many other organic acids may be formulated upon the principles which I have here laid down, and I venture to think that these principles will hereafter be found of extensive application. I have endeavored, and I believe with success, to reduce the formulas of the class of bodies known as glucosids to the types of multiples of water, but the recent publication of special researches of Berthelot has anticipated the principal results which I had obtained. I conclude with the expression of my conviction that every complex organic molecule is built up, not directly of the elements which it contains, but of simpler organic molecules, which are more or less perfectly fused together but which may yet in the majority be distinctly traced in the complex whole.

New York, Oct. 27th, 1857.

ART. IV.—*The Estimation of the Weights of very small portions of Matter;* by ALFRED MCMAYER, Professor of Physics and Chemistry in the University of Maryland.

THE chemist, in the course of his analytical investigations, often meets with what are called traces of substances; by which is generally understood, quantities of matter too minute to have any appreciable weight in the analytical balance. Now it sometimes happens that these traces are of as much importance considered scientifically and commercially as the ingredients present in appreciable quantities; and in order to estimate these small portions of matter he is often obliged to go over his work, using very considerable weights of substances, whereby his time and care are nearly doubled. It was this inconvenience that first induced me to try to determine in one operation the components present in large and in very minute quantities; and although I have succeeded beyond my expectations, I am confident that the process is susceptible of improvement, both as regards sensibility and accuracy.

After making many investigations on the sensibility of the most delicate levers as to small weights, this method was found far too rough. It then occurred to me that if instead of using the opposing force of gravity through the intervention of a lever, we could oppose to the gravitating effect of the matter the force of perfect elasticity as manifested in filaments of glass, we might succeed in obtaining the weights of extremely small parts of matter. For that purpose I tried the elasticities both of torsion and flexure, and found the latter only to answer the purpose.

The following is a description of the construction of my apparatus with which I have succeeded in estimating portions of matter equal in weight to the thousandth part of a milligram. Heating a rod of soft glass in one spot to bright redness, I drew it out quickly, and thereby obtained a filament uniformly cylindrical, of about the diameter of fine human hair. Taking from the middle of this fine glass thread a piece of such a length (about three inches) that its weight would barely reduce it from the horizontal, one end of it was fastened by means of good sealing wax to the edge of a mahogany block, and the other end slightly hooked by approaching quickly a small spirit flame. In order to obtain a pan in which to place the substance whose weight I would estimate, I cut with the common microscopic section-cutter some disks of elder pith from ·001 to ·002 inch in thickness; and drawing out a still finer filament, the end was likewise hooked, and the other extremity being passed through a pith disk, a small knob of glass was made on this end by the spirit flame, just of sufficient size to prevent this disk slipping

off the suspending rod. The filament with attached disk wa now hooked on the end of the rod fixed to the block, and wa then ready for graduation.

Not being able at the time to procure silver wire of sufficien fineness, I substituted some very fine and long hair, taken fror the head of a child; and having brought the centre of gravit and centre of motion of a very sensitive analytical balanc almost to coincide, I obtained a piece of the middle of a hai weighing exactly one-half milligram. This being divided int five equal parts (each about one inch long) gave us tenths c a milligram. One of these tenths being placed on the pitl pan, the glass filament was deflected a certain quantity, whic was marked on an arc formed of bristol board, and so as to b almost touched by the deflected rod in its revolution about th edge of the block. Another tenth was added and another divi ion obtained: and so on, until all five divisions were marke The length of the divisions being about one-fourth of an incl they were very readily subdivided into ten equal parts whic gave me immediately $\frac{1}{100}$ths of a milligram. The weight of an quantity of matter less than one-half milligram may be no estimated to $\frac{1}{100}$th of a milligram by placing it on the pan an observing the deflection.

For the thousandths, still more care and patience is require the filament being much finer and somewhat shorter, and the pit disk smaller and as thin as possible. In order to obtain th primary graduations of hundredths, one of the above pieces c hair equal to $\frac{1}{10}$th milligram is divided into ten equal part which gives us weights of $\frac{1}{100}$th milligram. The deflection caused by these weights, divided into ten equal parts, give $\frac{1}{1}$ of a milligram.

As the least breath of air interferes with the graduations an weighing, the whole instrument is protected by a glass case, th end of the case next the graduated arc being on a hinge.

In elastic rods of square section, the deflection is proportion to the weight; in those of circular section this law is slightl departed from; but by the above method of ascertaining directl the value of each division, the error is avoided.

Those who may have the necessity to construct this apparat should arm themselves beforehand with scrupulous care and u bounded patience.

From the great simplicity of the above arrangement, it seem very strange that some person did not long ago invent it; bu to my knowledge, it has never been attempted.

Baltimore, Md., Oct. 26th, 1857.

r. V.—*On the Behavior of the Carbonates of Lime and of* *'aryta in presence of various Saline Solutions. With remarks* *ı the Determination of Carbonic Acid in Mineral Waters;* by RANK H. STORER.

'HE object of the following article is to call attention to the 7 general influence which aqueous solutions of the alkaline s, including those of ammonia, exert in preventing the pre-tation of the carbonates of lime and of baryta. It will more-r be shown that solutions of the hydrates of baryta and of : when diluted with water, or with dilute solutions of the stic alkalies, are no longer precipitated by carbonic acid gas. convenience the latter subject will be first treated of.

. current of carbonic acid gas passed through baryta water, ted with two or three times its volume of water, until it was pletely saturated, afforded no precipitate at any moment ing the process, nor was any produced when the excess of onic acid was driven off by long continued ebullition. The tion even regained its strong alkaline reaction and a precipi- was at once formed in it, on addition of a solution of an line carbonate. If a dilute solution of caustic soda, potash, nonia or of lime be added to the baryta water, from which excess of carbonic acid has been driven by boiling, and the ition again boiled, a precipitate of carbonate of baryta is pro-ed; this precipitate does not form, however, if a sufficiently te solution of the caustic alkali has been used, unless the so-on be heated, while that formed on addition of a solution of alkaline carbonate falls even in the cold. There is also a it where less dilute solutions of the caustic alkalies produce cipitates in the cold when added to a solution which has rded no precipitate on boiling.

t should be mentioned that the foregoing refers to a solution ıydrate of baryta of constant strength, since at different de-s of concentration very different reactions may occur. Thus, oncentrated solutions a current of carbonic acid gas produces recipitate at once; in a solution slightly diluted it produces a cipitate only when heated; in a solution still more diluted no cipitate is produced even on continued ebullition.

'rom these experiments the two following conclusions may be wn. (1.) That baryta water when diluted loses, in great t, its power of absorbing carbonic acid gas. (2.) That a ll portion of carbonic acid remains, in solution, in the baryta er even in spite of long continued ebullition.

Vhen diluted with several times its volume of water, lime er also ceases to afford an immediate precipitate when car-ic acid gas is passed through it. A precipitate generally

forms on boiling, but if the lime water be much diluted no precipitate will occur even on actual ebullition, although solutions of the alkaline carbonates produce at once precipitates.

If to the lime water in which carbonic acid gas has produced no precipitate even after boiling, a dilute solution of caustic soda, ammonia or lime be added and the mixture heated, a precipitate of carbonate of lime will be formed. This shows that a small portion of carbonic acid is retained by the lime water even after long continued ebullition as it was by baryta water. Even saturated lime water is capable of retaining a portion of carbonic acid in solution for a considerable time if the solution is not heated. This is easily proved by passing carbonic acid into lime water until it is partially saturated, when on filtering and boiling the clear filtrate an abundant precipitate of carbonate of lime is formed. This precipitate dissolves with effervescence in dilute acids and presents the characteristic needles of aragonite when examined under the microscope. I have noticed that lime water which has been exposed to the air, as when kept in bottles with loosely fitting stoppers, affords an abundant precipitate of carbonate of lime on boiling, but if that which has been thus exposed be afterwards placed in a securely closed bottle it will deposit after a few days all the carbonate of lime which it had previously retained in solution and will no longer afford any precipitate of it, on boiling. The well known incrustation of hydrate of lime is always deposited when lime water is boiled, but this for the most part becomes firmly fixed to the sides of the vessel, presenting, even to the naked eye, a very dissimilar appearance from the precipitate of carbonate of lime and on examination with the microscope the crystals of hydrate of lime have the appearance of rectangular plates, while those of carbonate of lime (produced by ebullition) are acicular.

These remarkable reactions, namely, the nonformation of a precipitate when carbonic acid gas is passed into dilute baryta or lime water, must, I think, depend upon the affinity which the great mass of water present exerts for the baryta or lime, or, upon the inertia of the dissolved alkaline earth, in other words, its indisposition to separate from the water. Moreover, since the carbonates of the alkaline earths are somewhat soluble in water their tendency to form a precipitate must be, under the circumstances, comparatively slight. Baryta or lime and carbonic acid are thus capable of existing simultaneously in solutions in a quantity of water which would not redissolve a fraction of the amount of carbonate of baryta or lime which they would produce if once precipitated.

The actions of carbonic acid gas on solutions of caustic lime or baryta when mixed with dilute solutions of the caustic alkalies may be mentioned here as it seems to be connected with that where water alone is present.

ime water mixed with a *dilute* solution of caustic soda, pot-
or ammonia gives no immediate precipitate when carbonic
. gas is passed into it, unless the solution is boiled. Baryta
er yields analogous results. If with the latter, instead of
solution of soda, an equal bulk of water is used there will
10 precipitate even on boiling. This shows that when water
ie is present, the carbonic acid, at first dissolved, is driven
on the application of heat before it can react on the hydrate
aryta, while if soda is used this alkali retains the carbonic
l which, on heating, reacts upon the baryta.

pass next to consider the influence which aqueous solutions
he alkaline salts exert in preventing the precipitation of the
onates of lime and of baryta.

'hat solutions of many of the ammoniacal salts exert a solvent
rer upon the carbonates of lime and of baryta, especially
en recently precipitated, has been noticed by several observ-
(A. Vogel, *J. pr. Chem.*, vii, 453; Wittstein, *Report. f. Pharm.*,
, 18; Wackenroder, *Ann. Pharm.*, xli, 315; Brett, *London*
Edin. Phil. Mag. and Journal of Science, x, 95). Solutions
he salts of potash have also been noticed to possess the
ie power, though to a less degree, and I find that the
s of soda stand midway in this respect between those of
nonia and of potash, and that even chlorid of calcium exerts
ertain solvent power upon recently precipitated carbonate
lime.

This solvent action may be seen by treating the recently pre-
itated carbonate with a great excess of a solution of almost
alkaline salt, but is observed more distinctly in the great
dency of the alkaline salts to prevent the precipitation of the
bonates of the alkaline earths. Thus, if lime water be mixed
h an aqueous solution of chlorid of ammonium, chlorid of
ium or chlorid of potassium, and a current of carbonic acid
be passed into the mixture no precipitate is produced, even
boiling, if the alkaline chlorid be present in sufficient quan-
. If less of the alkaline chlorid has been used there will be
recipitate formed on boiling although none has occurred in
cold. Chlorid of calcium exerts an action entirely analogous
that of the alkaline chlorids, though, so far as I have observed,
recipitate always forms on boiling.

A solution of sulphate of ammonia or of sulphate of soda,
en mixed with lime water exerts an influence almost pre-
ely like that of the alkaline chlorids, carbonate of lime not
ng precipitated even on boiling if they are present in suffi-
nt quantity.

A solution of sulphate or of nitrate of potash behaves much
e that of sulphate of soda, but its influence is less strongly
rked.

From the extreme facility with which water alone prevents the precipitation of baryta water by carbonic acid, it is difficult to judge of the influence which salts in solution in it may exert. Chlorid of ammonium, however, retards in a marked manner the precipitation of carbonate of baryta from baryta water, a portion remaining in solution even after boiling with carbonate of soda. Chlorid of sodium and of potassium also retard in a measure the precipitation of carbonate of baryta, but their action is not well marked.

The solvent influence of the alkaline salts can be observed with equal facility by mixing their solution with that of an alkaline carbonate and adding a solution of a lime or baryta salt to the mixture. A few examples will illustrate this point.

(1.) A solution of chlorid of calcium produces no precipitate, except on boiling, when added to a mixed solution of carbonate of soda and sulphate of soda excepting when the carbonate is in excess. In this experiment the sulphate of soda may be replaced by any of the alkaline sulphates or chlorids.

(2.) A solution of chlorid of barium produces no precipitate, except on boiling, when added to a mixed solution of carbonate of soda and chlorid of ammonium and if the latter be present in considerable quantity there will be no precipitate even on boiling. When the chlorid of ammonium is present in smaller quantity there is a point where the addition of a drop of carbonate of soda produces a cloudiness which clears up on heating.

(3.) If in the last experiment chlorid of sodium be substituted for chlorid of ammonium a similar action may be observed although it is much less in degree. In one experiment in which an excess of carbonate of soda was used and a partial precipitate produced in the cold, the liquid was left in repose during twenty-four hours, but on being filtered and the clear filtrate boiled, an additional amount of carbonate of baryta separated.

(4.) When a mixed solution of carbonate of soda and nitrate of potash is quickly added, in large excess, to a small quantity of a solution of chlorid of barium or of hydrate of baryta, no immediate precipitate is produced except on boiling.

The most remarkable solvent action which I have noticed is seen in the inability of the alkaline carbonates to precipitate baryta, and especially lime, from their solutions, when added in great excess. That such solvent power exists may be proved by precipitating a small quantity of a salt of lime with carbonate of ammonia and then redissolving the precipitate in a very great excess of the precipitant. But a much more satisfactory proof may be obtained by adding quickly a large excess of the solution of the alkaline carbonate to a small portion of a dilute solution of a lime or baryta salt; so quickly that the precipitate

y not have a sufficient time to form. This is readily accomshed by swinging rapidly the vessel containing the solution of : lime or baryta salt and suddenly turning into it the solution the alkaline carbonate. If the solutions have been used in oper proportion no trace of a precipitate will appear, owing to : complete mixture obtained by this method of experimenting, hough a fractional amount of the lime salt used would have oduced a persistent precipitate had it been slowly added. By ng the same portion of the solution of the alkaline carbonate on successive small portions of that of the lime salt no inconerable amount of the latter may be finally obtained in solun. As a rule this solution is precipitated at once on boiling, t if it be diluted with a large quantity of water, ebullition no iger produces any precipitate. In one instance such a solution t in repose during twenty-four hours afforded no precipitate, hough oxalate of ammonia when added to it produced a coous precipitate of oxalate of lime.

I have detailed but a few of the many cases where the presce of alkaline salts exerts an influence to retain lime or bata in solution simultaneously with carbonic acid, but enough s been said to show that this power is quite general and that : salts of potash and of soda act in this respect like those of imonia.

That the power of the alkaline salts to retain the carbonates lime and baryta in solution may be referred to affinities analous, in kind, to those which cause them to form double salts th the compounds of zinc, lead and magnesia, is, I think, evint. It is true that the affinities here are much weaker and inficient to produce stable crystalline compounds. As in many ier cases of double elective affinity, some shock, such as agitan or the application of heat, is required to call a desired play affinities into action,—so here the affinity of the alkaline salt the carbonates of the alkaline earths is sufficient to retain the ter in solution until heat is applied.

The well known fact that a current of carbonic acid gas proces no immediate precipitate in a solution of a salt of lime or baryta neutralized by ammonia seems to depend on a mixed ion: in part, like that previously alluded to, which prevents : precipitation of carbonate of baryta when a current of carnic acid gas is passed through dilute baryta water, and also the tendency of the carbonates of lime and baryta to form mpounds with the salts of ammonia.

I find that a weak solution of caustic soda, potash or even ne may be substituted for caustic ammonia in the above ixture with like result, no precipitate appearing until after e lapse of considerable time unless the solution be heated. he action of the fixed alkali being, to all appearance, en-

tirely analogous, in kind, to that of ammonia, although less in degree.*

To demonstrate this it is only necessary to employ sufficiently dilute solutions of the caustic alkalies and to pass through the mixture a stream of carbonic acid gas diluted with air,—air expired from lungs, for example,—when no immediate precipitate will be produced unless the solution be heated. Even if the solution of caustic alkali be used in so concentrated a form (not sufficiently so however to precipitate a hydrate of the alkaline earth) that a precipitate of carbonate of lime is produced, in the cold, by a current of carbonic acid, it can readily be proved that a portion of the carbonic acid has not been precipitated, by filtering and boiling the clear filtrate, when a copious precipitate of carbonate of lime will be produced at once. This behavior is more marked with lime salts than with those of baryta, and soda evidently exerts a greater influence than potash.

If a solution of chlorid of sodium, of chlorid of potassium, or of chlorid of ammonium be added to the mixed solution before passing carbonic acid gas the precipitation of the carbonate of lime or baryta is attended with still greater difficulty.

Attention has been called by several observers (among others Rant, *J. pr. Chem.*, ii, 440; Vogel, *ibid.*, vii, 453) to errors which may arise in the course of analysis if the solvent action of chlorid of ammonium upon the carbonates of lime and of baryta be not kept in view. The remark applies with similar force to most of the soluble alkaline salts. This is of special importance in the determination of carbonic acid by means of a solution of chlorid of calcium neutralized with caustic ammonia. As a remedy it has been suggested (Kolbe, *loc. cit.*; Mohr, *Titrirbuch*, i, 110 and 113) that the solution should be boiled, in order to throw down all of the carbonate of lime. This would, it is true, in most cases cause the entire precipitation of the carbonate. But it is possible, especially in the analysis of some mineral waters, that alkaline salts may be present in sufficient quantity to prevent the precipitation of a portion of the carbonate of lime even on ebullition.

* Kolbe (*Handwoerterbuch der Chem.*, I Supplem., S, 157,) explains the behavior of the solution of chlorid of calcium or barium neutralized with ammonia, by supposing that an organic compound carbamate of ammonia, $NH_4O, C \left\{ \begin{matrix} O \\ AdCO_2 \end{matrix} \right.$ is formed, capable of existing for some time in cold aqueous solution but not of supporting heat, on application of which it is transformed into ordinary carbonate of ammonia which reacts at once on the lime or baryta salt present. The insufficiency of this view to explain all the facts in the case is evident: (1.) In presence of an excess of chlorid of ammonium, carbonic acid produces no precipitate in the mixed solution of chlorid of calcium and ammonia even when it is boiled. (2.) When a large excess of any alkaline carbonate is added to a small amount of a solution of a salt of lime or of baryta, no immediate precipitate is produced unless the solution be heated. (3.) A current of carbonic acid gas produces no immediate precipitate in a solution of chlorid of calcium or chlorid of barium which has been neutralized with a dilute solution of caustic soda or potash instead of ammonia.

Bearing on this subject is the fact noticed by Denham Smith Lond. and Edin. Phil. Mag. and Journ. of Science, ix, 542), that he carbonates of lime and of baryta are rapidly decomposed when boiled with solutions of the ammoniacal salts, carbonate of ammonia being evolved. This appears to have been overlooked by the above cited observers, but the fact can be easily proved by adapting an abduction tube to a flask containing a solution of chlorid of ammonium and some carbonate of lime, boiling the mixture and passing the vapor generated into lime water, when a copious precipitate of carbonate of lime is at once produced, and this in spite of the retarding influence of the ammonia present. As carbonate of baryta appears to be affected in much less degree than carbonate of lime by the solvent action of the alkaline salts, and to be capable of separating entirely in the cold from such solution after sufficient time, the use of chlorid of barium in determining carbonic acid would seem to yield more accurate results than that of chlorid of calcium.

ART. VI.—*On the Heights of the Tides of the Atlantic Coast of the United States, from observations in the Coast Survey;* by A. D. BACHE, Superintendent.—With a Plate.

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

IT is well known that when a bay or indentation of the coast presents its opening favorably to the tide wave, and decreases in width from the entrance towards its head, that the tides rise higher and higher from the mouth upwards. The Rev. Mr. Whewell has stated that in a general way the same fact is deduced from the observations on the coast of Great Britain and Ireland, discussed by him.

The Coast Survey observations of the tides of the Atlantic coast, the results of which, from time to time, I have brought before the Association, furnish the means of a complete discussion of heights as well as of times, and very simple generalizations result from their examination. Through the kindness of Captain Shortland, R. N., and of Admiral Bayfield, R. N., I have been enabled to extend these results to the coasts of New Brunswick, Nova Scotia, and to part of Newfoundland.

I beg leave to make my best acknowledgements to these distinguished hydrographers for the prompt and liberal communication of the results of their observations.

The Coast Survey observations have been worked up in the tidal division under the direction of Assistant L. F. Pourtales, and I am indebted to him for giving the results the shape desired and for the diagrams representing them.

The following table of stations on or near the exterior coast-line of the United States, is taken from the more extended tables of the Coast Survey, omitting stations which are up rivers or bays, except in special cases the object of inserting which will be obvious.

Table A contains a number for reference, the locality of the tidal station, the state to which it belongs, the latitude, the longitude, and the mean height of the tide in feet and tenths.

TABLE A.

Heights of Tides on the Atlantic Coast of the United States.

No.	Locality.	State.	Lat.		Lon.		Heights in feet.	No.	Locality.	State.	Lat.		Lon.		Heights in feet.
			°	′	°	′					°	′	°	′	
1	Portland,.....	Me.	43	39	70	14	8·8	22	Fire Island,.....	N.Y.	40	38	73	13	2·1
2	Portsmouth,...	N.H.	43	04	70	42	8·6	23	Sand's Point,....	"	40	52	73	43	7·7
3	Newburyport,.	Mss.	42	48	70	52	7·8	24	Sandy Hook,....	"	40	28	74	00	4·8
4	Gloucester, ...	"	42	37	70	40	8·9	25	Cold Spring Inlet,	N. J.	38	57	74	45	4·4
5	Salem,.......	"	42	31	70	54	9·2	26	Cape May,......	"	38	56	74	57	4·8
6	Boston, ...	"	42	22	71	03	10·0	27	Old Pt. Comfort, .	Va.	37	00	76	18	2·5
7	Plymouth,....	"	41	57	70	40	10·1	28	Hatteras Inlet, ..	N. C.	35	12	75	43	2·0
8	Provincetown,*	"	42	03	70	11	9·2	29	Beaufort, ...	"	34	42	76	40	2·8
9	George's Sh'ls,†		41	40	67	45	7·0	30	Cape Fear, ...	"	33	52	78	00	4·4
10	Monomoy,....	Mss.	41	33	69	59	3·8	31	Winyah Bay,....	S. C.	33	14	79	8	3·8
11	Siasconsett,...	"	41	15	70	00	2·2	32	Charleston, ...	"	32	46	79	54	5·0
12	Weeweeder, ..	"	41	15	70	05	1·2	33	N'th Edisto River,	"	32	33	80	13	5·8
13	Smith's Point,.	"	41	17	70	16	2·1	34	Port Royal,.....	"	32	17	80	40	7·0
14	Wasque, ...	"	41	21	70	30	1·7	35	Savannah Entr...	Ga.	32	02	80	53	7·0
15	Menemsha, ...	"	41	20	70	45	2·7	36	Sapelo, ...	"	31	21	81	24	6·6
16	Point Judith,..	R. I.	41	22	71	29	3·1	37	St. Simons, ...	"	31	8	81	36	6·8
17	Newport,.....	"	41	29	71	20	3·9	38	St. Mary's River,.	"	30	42	81	36	5·9
18	Block Island,..	"	41	10	71	34	2·8	39	St. John's River, .	Fla.	30	20	81	33	4·6
19	Montauk Point,	N.Y.	41	04	71	51	1·9	40	St. Augustine,...	"	29	52	81	25	4·2
20	Stonington, ...	Ct.	41	20	71	54	2·3	41	Indian River Inlet,	"	27	28	80	19	2·5
21	New Haven, ..	"	41	18	72	54	5·8	42	Cape Florida,....	"	25	40	80	09	1·5

The following table of tides of localities on the coast of Cape Breton, Nova Scotia and New Brunswick, is from the observations of Admiral Bayfield and Captain Shortland. The authorities are given in the column of remarks, which also contain the remarks of Admiral Bayfield on the tidal results communicated by him. I have taken from his table the heights which were derived from the greatest number of observations. The column of means is the average of the heights of spring and neap tides in feet and tenths. The localities are arranged from the north southward on the outer coast; and in the Bay of Fundy from the entrance up the bay.

From the table of Captain Shortland I have selected only a few localities as specimens, having no wish to anticipate, through his generosity, the use which he will doubtless make of his own results.

* Major Graham, U. S. A. † Capt. Wilkes, U. S. N.

Heights of Tides on the Coast of Cape Breton, Nova Scotia and New Brunswick.

No.	Localities.	Remarks on Localities.	Lat. °	Lat. ′	Lon. °	Lon. ′	Rise of Tide. Ord. Spring ft.	Ord. Spring in.	Ord. Neap. ft.	Ord. Neap. in.	Mean. ft.	Remarks and authorities.
	Is'd of Cape Breton.											Admiral Bayfield.
1	St. Ann's Harbor, .	Entrance,...........	46	17	60	33	5	0	3	3	4·1	A complete semi-lunation observed.
2	Sydney Harbor, . .	S. E. Bar,...........	46	12	60	13	3	9	2	4	3·1	At full moon and a day or two before and after.
3	Menadou Harbor, .	Near Scataria Island,.	46	00	59	50	5	6	3	4	4·4	Good. A complete semi-lunation observed.
4	St. Peter's Island, .		45	36	60	49	6	0	4	0	5·0	At new moon and a day or two before and after.
5	St. Peter's Bay, . . .	Haul-over at head of Bay,...	45	39	60	52	5	9	4	1	4·9	Good observations, four times observed, twice at the full, and twice at the new moon, with several days before and after.
6	Grandigue,.......	In Lennox passage, . .	45	36	61	01	6	4	4	6	5·4	Good, a complete semi-lunation observed.
7	Arichat Harbor,. . .	Jerseyman Isd, N. poi't,	45	30	61	03	5	0	4	0	4·5	ditto. ditto. ditto. Extraordinary tides, rise 6 feet.
	Nova Scotia.											
8	Canso Harbor,. . . .	E. end of Cutler's Is'd.	45	21	60	59	6	6	4	6	5·5	A complete semi-lunation observed, but tides very irregular.
9	White Haven, ...	Marshal Cove, ...	45	15	61	11	6	1	4	1	5·1	A complete semi-lunation observed, good observations.
10	Harbor Island, . . .	N. E. Point,.........	45	08	61	36	6	6	4	6	5·5	A complete semi-lunation observed, extraordinary tides, rise 7 feet.
11	Liscomb Harbor,. .	Pye's Wharf,........	45	00	62	01	6	0	4	0	5·0	Three times observed at full and new moon, and several days before and after.
12	Sheet Harbor, ...	Watering Cove, ...	44	54	62	30	6	8	4	6	5·6	Good—two complete semi-lunations observed.
13	Pope Harbor,.	Harbor Isd., N.E.Point,	44	48	62	39	6	6	4	2	5·3	Three times observed at full and new moon.
14	Ship Harbor, ...	Salmon Point,........	44	47	62	49	6	5	4	10	5·6	Good, a complete semi-lunation, extraordinary spring-tides, rise 7 feet, and extraordinary neaps, only 4 feet.
15	Jedore Harbor, . . .	Marsh Point,........	44	43	63	00	6	6	4	8	5·6	Two good and complete semi-lunations observed.
16	Halifax Harbor,. . .	Naval Yard,.........	44	40	63	35	6	0	4	6	5·2	Mean of a complete year's observations with a tide gauge.
	Bay of Fundy.											Captain Shortland, R. N.
17	Cape Sable,......	Cape Sable Island, Clarke's Harbor,. . .	43	25	65	39	11	6	4	11	8·2	
18	Ellenwood's Island,	Bird Rock,..........	43	39	66	04	12	7	7	0	9·7	
19	Yarmouth Harbor,	Fourchue Isd. lighth'se,	43	47	66	10	10	9	16	0	13·3	
20	Bryer's Island,. . . .	Peter's Isd. lighthouse,	44	15	66	21	20	6	9	3	14·8	
21	Campbell's Island,.	Owen's House, ...	44	54	66	58	25	0	11	0	18·0	
22	St. John's, N. B. . . .	Battery Point Rock,. .	45	16	66	04	26	8	12	0	19·3	
23	Shadwood Point,. .	Cumberland Basin,. . .	45	54	64	22	50	0	22	0	36·0	

These numbers may be extended beyond the turn of Cape Race, where the coast trends to the west of north, by further results of Admiral Bayfield, though the remarks which he makes show them to be only approximate. Thus two stations on the coast of Labrador, St. Lewis Bay in latitude 52° 19′ and longitude 55° 37′, and Henley Island in latitude 52° 00′ and longitude 55° 53′, give each for the mean of the height of spring and neap tides 2·3 feet. St. John's, Newfoundland, gives 5·0 feet. Trepassey harbor, south of it, 5·8 feet.

Beginning with the southern end of table A and following the results northward and eastward, we find from Cape Florida to Savannah and Port Royal a gradual increase of the tides, and then a gradual decrease to Cape Hatteras, with a single contradiction easily explained. Next, following the stations on the coast, and omitting those in the bays and sounds, we have a less regular increase to Sandy Hook, and a decrease to Weeweeder on Nantucket Island. Next is a less regular regimen requiring a more detailed examination.

By developing the curved line of the coast into a straight line and marking upon it the tide stations, which will be thus at nearly their proper distances from each other, and by erecting ordinates at each of the station points and setting off on a suitable vertical scale the heights of the tides at those points, and connecting the extremities of the several ordinates, we have the broken line shown in diagram A. In drawing this line the stations of the coast only are joined, and the irregularities are cut off by the curve.

This curve shows distinctly the *physical* division of the coast between Cape Florida and Cape Sable into three great bays. The great southern from Cape Florida to Cape Hatteras, the great middle from Cape Hatteras to Siasconsett, the great eastern from Siasconsett to Cape Sable. Perhaps this latter may be considered as only a portion of a great bay from Siasconsett to Cape Race; but this generalization is at present hardly safe, and I confine myself therefore to the more limited view. The tide wave setting into the southern bay, rises as the bay contracts, and the heights of the tides along the shores increase as the places are more distant from the chord spanning the entrance.

If we suppose the lines of equal height to be straight lines and draw them upon the diagram, transferring them to a map of the coast, we shall find that they are more crowded on the more curved side and more open on the less curved. The curve indicates Cape Hatteras, and not the inlet, which was the tidal station, as the point of least height. The physical cause of this phenomenon is well understood if it has not yet been reduced to measure.

The next curve shows us plainly the middle bay, having Hatteras for its southwestern cape, and Smith's Point or Weeweeder

for its northeastern entrance. The form of the shore is less favorable to regularity, but the result is nevertheless well marked. The interference of tidal waves, which takes place off Nantucket, tends also in a degree to confuse the results. The chart shows how simple the system of cotidal lines is in the three bays running nearly parallel to the shores.

The eastern bay lies between the eastern part of Nantucket (Siasconsett) and Cape Sable, Massachusetts bay being subsidiary to this. The tide wave entering the eastern bay follows the deep water, and thus the cotidal lines take generally the directions of the shores until the tide wave enters the Bay of Fundy. The most probable form of the cotidal lines from XI to XV hours inclusive is shown upon the chart, which is merely an extension of the chart of cotidal lines of the United States coast formerly presented to the Association. The heights increase rapidly from Nantucket to Cape Cod, being 2 feet at Siasconsett and 9·2 feet at Provincetown. At Cape Ann they are nearly of this same height and increase in passing up and into the bay to 10·0 feet at Boston and 10·1 feet at Plymouth.

The height at Newburyport is probably local, depending upon the position of the tide-gauge. There is but little change from Portsmouth to Portland, and from Cape Sable to Ellenwood's Island.

Shall we look to the greater bay between the Nantucket and Newfoundland shoals for the cause of the eight feet rise at Cape Sable, and of the heights from Admiral Bayfield's table. We find the heights along the coast of Nova Scotia to vary from seven to six feet, not with regularity however. At Cape Breton Island they vary from 6·4 to 4·6 feet, decreasing thus in going northward and eastward. Are these heights due to the crowding of the waters into this greater bay? If so, why are not the heights of Cape Breton greater than those of Nova Scotia? We require results on the south shores of Newfoundland and on the Great Bank to give us clear ideas on these points, and I hesitate to extend the generalization to this tempting field.

The shoals from Nantucket and broken ground near George's Bank and the comparatively shoal water in their vicinity on the one side, and the Great Bank of Newfoundland on the other, look as if full of meaning of this sort. Further results may however show that this is not the interpretation of the phenomena. The tides of Labrador are but 2·3 feet, bringing us back to the standard of Hatteras and of Montauk Point, and what probably would be that of Nantucket but for interferences.

Soon after passing Mt. Desert on the west side and Ellenwood's Island on the east side, the tide wave has turned into the Bay of Fundy, and the rise increases with extraordinary rapidity. The complicated character of the cotidal lines in this immediate

vicinity is indicated by the chart, the lines from XII to XV hours being crowded into the very small space of a few miles on the south side of Nantucket.

To return to the more limited scale within which our inductions are safe, Delaware bay, New York bay, Long Island sound, Narragansett and Buzzard's bays, Nantucket and the Vineyard sounds, present on a smaller scale the same phenomena of increase in the height of the tide in ascending. On the contrary, in Chesapeake bay, which widens and changes direction at a right angle immediately from the entrance, the tides diminish in height as a general rule in going up the bay.

The results of the heights of tides along the coast are very satisfactorily shown upon a model which is now before the Association, for superintending the execution of which I am indebted to Mr. Pourtales. The basis is a map of the Atlantic coast from Cape Florida to Cape Race, upon which the cotidal lines of the United States are traced. The tidal stations are marked upon this, and rods cut to length and proportionate to the rise and fall of the tides at the several stations, are inserted in holes drilled at the station points. The steel rods refer to the heights at exterior stations and the brass rods to interior ones. Paper cut to the form of the general curve of heights, which has already been explained, and placed behind these rods, serves to show the generalizations with great distinctness.

I propose to call the bay between Cape Florida and Cape Hatteras the Southern bay, that between Cape Hatteras and Nantucket the Middle bay, and that between Nantucket and Cape Sable the Eastern bay of the coast of the United States.

The general figure of the coast line has of course heretofore attracted the attention of geographers. The connection with the heights of the tides could only satisfactorily be made out by such a series of tidal observations as those embraced in the Coast Survey.

ART. VII.—*On the Winds of the Western Coast of the United States, from observations in connection with the U. S. Coast Survey;* by A. D. BACHE, Superintendent.—With a Plate.

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

THE observations, of which I propose at present to communicate the results, were made in the year 1855, in connection with the tidal observations on the Pacific coast, at three permanent stations, Astoria, San Francisco, and San Diego. The approximate latitude and longitude of each of the stations is as follows:

Astoria, Oregon,	lat. 46° 11′ N.,	long. 123° 49′ W.
San Francisco, California,	" 37 48	" 122 28
San Diego, "	" 32 40	" 117 12

The mode of observing was that described in my paper on the winds at Cat Island, read before the Association in 1850. The observers were posted and practised together by Lieut. W. P. Trowbridge of the U. S. Corps of Engineers, under whose supervision the observations were made.

The directions of the wind were noted in points, and the force in the conventional scale before referred to. These numbers were reduced to velocity in miles per hour by the tables given in my former paper, and the quantity of wind blowing from any quarter during a given period was thence readily found. The tables and diagrams are thus of the same kind as those which I have before presented to the Association. They were made under the direction of Assistant L. F. Pourtales of the U. S. Coast Survey, to whose care, assiduity and knowledge I am indebted for the opportunity of presenting them. The computations and the diagrams were made by Miss Mary Thomas.

The observations were taken three times each day, at 6 A. M. and P. M. and at noon, except on Monday of each week when hourly observations took the place of the regular daily ones. From these latter results the reference of the three daily observations to the mean of the day has been made. The quantities of wind for each hour and for each direction were computed and grouped by months and then plotted. The eye readily takes in the characteristics of the winds at different periods of the day and year and for the various directions. To apply these to the reduction of the daily observations, tables were formed of the average time during which each wind blowing would give from observations at the three hours already named the result for the day. For example, the W. wind at San Francisco gave for the quantity in twenty-four hours by the daily observations 505, the mean hourly quantity at 6 A. M. being 6, at 12 M. 27, and 6 P. M. 31. These quantities respectively being supposed continued for nine hours, five hours, and ten hours, which agrees with the diagram, would give 499, a number differing but little from the total found for the day.

Table for deducing from the three daily observations the mean of the day.

ASTORIA.				SAN FRANCISCO.				SAN DIEGO.			
Wind.	6 A. M.	12 M.	6 P. M.	Wind.	6 A. M.	12 M.	6 P. M.	Wind.	6 A. M.	12 M.	6 P. M.
N.E.	6h	6h	6h	N. & N.E.	9h	6h	9h	N. & N.E.	6h	6h	6h
E. (Oct. to Mar. incl.)	9	6	9	E.	3	3	3	E.	3	3	3
E. (Apr. to Sept. incl.)	3	3	3	S.E., S. & S.W.	9	6	9	S.E. & S.	9	6	9
S.E.	6	6	6	W.	9	5	10	S.W. & W.	18	6	6
S.	9	6	9								
S.W. & W.	9	6	9	N.W.	9	6	9	N.W.	18	7	6
N.W.	8	5	7								
N.	3	3	3								

In this way the above table was found, which was applied to the reductions of the daily observations.

From the tables of velocities in miles per hour deduced from the observations by the method just explained, the following table of quantities of wind from different directions for each

QUANTITIES OF WIND.

ASTORIA.

Month.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
January, ...	6	795	987	150	324	2719	1539	....	6520
February, ...	138	282	1623	295	3079	225	850	....	6492
March, ...	....	....	1253	509	933	585	428	....	3708
April, ...	24	180	305	282	1218	969	1651	1801	6430
May, ...	....	102	105	186	536	1437	876	1393	4635
June, ...	....	60	33	....	9	258	2104	2760	5224
July, ...	....	150	18	....	....	633	700	4221	5722
August, ...	....	6	12	60	30	279	180	2543	3110
September, ...	....	54	....	102	872	....	246	431	1705
October, ...	....	754	294	....	1245	291	123	361	3068
November, ...	....	583	182	399	2252	2927	348	447	7138
December, ...	....	1535	456	693	2849	138	105	91	5867
	168	4501	5268	2676	13347	10461	9150	14048	

SAN FRANCISCO.

Month.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
January, ...	2302	375	147	177	21	1471	264	1161	5918
February, ...	618	180	45	558	147	992	860	306	3706
March, ...	218	60	28	639	470	1934	2447	426	6222
April, ...	30	72	....	168	312	2992	4845	209	8628
May, ...	....	....	....	348	24	1578	4928	2530	9408
June, ...	....	....	....	....	18	8338	3428		11784
July, ...	....	....	....	....	9	8725	2020	362	11116
August, ...	....	....	....	....	....	2608	3908	2168	8684
September, ...	....	....	....	....	54	2588	4219	500	7361
October, ...	....	6	....	....	63	136	4396	96	4697
November, ...	630	252	....	231	232	508	2056	222	4131
December, ...	414	850	18	652	489	1290	1576	234	5523
	4212	1795	238	2773	1839	33160	34947	8214	

SAN DIEGO.

Month.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
January, ...	91	147	45	431	813	384	643	987	3541
February, ...	204	48	207	1291	777	688	278	2461	5954
March, ...	284	114	114	1095	726	912	1124	3219	7588
April, ...	186	180	36	900	1019	798	810	2505	6434
May, ...	156	24	57	396	834	1296	930	2296	5989
June, ...	72	48	66	1100	827	882	892	2145	6032
July, ...	39	192	16	285	1320	607	120	4066	6645
August, ...	48	79	24	104	93	595	690	3823	5456
September, ...	48	186	39	54	265	338	426	2418	3774
October, ...	72	156	21	36	132	186	254	2411	3268
November		108	93	240	231	542	198	1226	2638
December, ...	114		24	162	545	686	528	754	2613
	1314	1282	742	6094	7382	7914	6893	28311	

month is found. The rhumbs are written at the top of the table, the months at the side, and at the meeting point of a vertical and horizontal line from the head and side titles are found the quantities. The last column at the side of the table gives the total quantities for the several months, and below is found the totals for each direction for the year.

From this table the diagrams representing the quantities for each month from each direction (figs. Nos. 1 to 12) are taken, and also those showing the total annual quantities of wind from each direction, and the total quantity of wind from all directions for each month (figs. Nos. 16 and 17).

It seems to me altogether probable from the study of the figures of these tables, that the scale adopted by the observer at San Francisco is greater than that at the two other points. The total quantities at Astoria, San Francisco and San Diego are as 59, 87, and 60, and it is hardly probable that there is so large an excess of quantity at San Francisco. I have also the same remark to make as on the observations at Cat Island, on the absence of observations upon the intermediate points between the cardinal ones, showing the tendency to designate the winds only by the cardinal points.

From these diagrams we see at once the simple general regimen of the winds on this coast.

1. The great prevalence of westerly winds, representing a flow of the air at the surface from the ocean in upon the land.

2. The general absence of easterly winds, showing the absence of a return current at the surface.

The proportion of westerly to easterly winds is as 8 to 1.

3. The increase of westerly winds in the summer and their decrease in the winter.

4. That when easterly winds blow at all, it is as a rule during the winter.

5. The N., N.E., and E. winds blow more frequently in the morning than in the afternoon hours.

6. The S.E., S., and S.W. winds are in general pretty equally distributed over the morning and evening hours.

7. The N.W. is the prevailing direction of the ordinary sea breeze at Astoria and San Diego, and the W. at San Francisco.

Sometimes the W. wind has that character at the first named stations and sometimes the S.W. wind at the last named.

A closer inspection of the same diagrams will lead to other interesting results.

Considering the qualities of wind at the three places for the whole year (fig. No. 13) San Diego and Astoria present remarkable similarities. There is more N.E., E., and S. winds at Astoria, and more N.W. wind at San Diego. The axis dividing the area symmetrically is in the same direction. On the contrary

at San Francisco the W. and S.W. winds give the character to the rose and the axis makes an angle of some sixty-seven degrees with that of the other spaces. All show the same deficiency of easterly winds, and San Francisco is deficient also in southerly ones.

The monthly curves grouped in two periods, from November to March, both included, and from April to October (figs. Nos. 14 and 15) show that the annual curve has the summer type impressed upon it. The summer is in fact the windy part of the year. The N.W. wind prevails in August at Astoria and San Diego, and the W. and S.W. at San Francisco.

The scale of diagram No. 14 is less than that of 15 in the proportion of 10 to 14. There is scarcely any wind from points between North, around by East and South. The form of the rose is exceedingly simple and the generalization very obvious.

The winter system is less simple. The axes of the spaces for Astoria and San Diego make angles of more than 110° with each other. The N.E., E., S., and S.W. winds are considerable at Astoria, and the N.W. wind is deficient. At San Francisco the W. winds give the prominent feature to the rose curve.

As the winter is not the windy season, so the months of March and September are not the windy months. On the contrary, July is one of the windiest months of the year.

San Francisco.

At San Francisco the great current of air flowing from the sea to the land comes generally from the W. or S.W., rarely from the N.W.

In the period from November to March inclusive, (diagram No. 14,) the W. is the prevailing wind, exceeding in quantity both the others, the S.W. wind exceeding in quantity the N.W. In the period from April to October (diagram No. 15) the W. and S.W. winds are nearly equal, and each exceeds the N.W.

The W. wind has in general the features attributed to the sea breeze, beginning after the rising of the sun, increasing until after the hottest part of the day, and dying out or much diminishing at nightfall.

The W. and S.W. winds give the prominent features to the wind rose at San Francisco.

The S.W. is the prevailing wind in June and July, S.W. and W. winds blowing nearly the whole of those months, not succeeded by an easterly land breeze—but rising and falling. The rose curves for May and August resemble each other, the N.W. and S.W. winds being nearly equal in quantity, and each less than the W. wind. So the curves for April and September, when the N.W. wind has nearly died out. The W. wind diminishes in quantity through March and February, and through

ober, November, and December to January. The N.W. ıd increases again from April towards December, and is very ıll in October and November. The S.W. wind disappears in :ober, changing the form of the rose curve, but reappearing November and December and increasing towards January. e W. wind has a maximum in April and May and another September and October, the minima being July and January. The N. wind in December, January and February, reaching a ximum in January, is the only other point to be noticed for ı Francisco, partaking with the other places in the general ab- ce of easterly winds. The tables show a little in the winter. ere is also but little S. wind there.

Astoria and San Diego.

In general the winds at these two places resemble each other re than those at San Francisco do either. The rose curves April, May, June, July and August (Nos. 4 to 8) have the ne general character. The mean curve for the year (No. 13) l for the summer period (No. 15) have also the same general ıracter.

The N.W. wind is the summer wind and has the characteris- ı of the sea breeze, but there is no return land breeze. The W. wind reaches a maximum in July and a mininum in De- nber. It is the great prevailing wind of the year (diagram . 13) at San Diego. As it decreases it is generally replaced W. and S.W. winds of less quantity. In December the ıntities of the three winds are nearly equal.

The resemblance of these winds at San Diego and Astoria is ıarkable, the remarks just made applying generally to both ces. There is, however, much less N.W. wind at Astoria n at San Diego. Except in June, July and August there is ıe S. wind each month at Astoria, and especially from Sep- ıber through October, November, December and February, it sents a marked feature of the rose. At San Diego this is ı marked, the two agreeing most nearly in quantity in March, ril and May.

The S.E. wind is a distinct feature in both places in February l March, and at San Diego in April and June.

The E. wind is prominent at Astoria in January, February l March, and the N.E. from October to January inclusive.

Astoria has the most easterly wind, the N.E. beginning in Oc- er and blowing until February, and being replaced by the E. ıd in March.

ART. VIII.—*Notes on the Measurement of a Base for the primary triangulation of the Eastern Section of the Coast of the United States, on Epping Plains, Maine;* by A. D. BACHE, Superintendent U. S. Coast Survey.—With a Plate.

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

THE reconnoissance for a base of verification at the eastern extremity of the primary triangulation in Section I of the coast was commenced by Charles O. Boutelle, Esq., and Major Henry Prince, U. S. A., Assistants in the Coast Survey, in 1853 and continued through 1854 and 1855. The absence of long and straight sea beaches on this coast rendered it absolutely necessary to look for an interior site.

The reconnoissance resulted in the selection of Epping Plains, Washington Co., Maine, as the most suitable site for the purpose considering the character of the ground itself and the facility of connecting the ends of the base with the primary triangulation.

In this selection and the examination of the plains, these officers were much assisted by the local knowledge and the kind offices of J. A. Milliken, Esq., now of Cherryfield, to whom I beg leave here to return the thanks of the Coast Survey.

Major Prince being relieved from the survey, the final minute examination of the site and the determination of the best line which could be obtained on the plain, devolved upon Assistant Boutelle, who was assisted at different times by Sub-Assistant J. A. Sullivan, Lieut. J. C. Clark, U. S. A., and Mr. F. P. Webber.

Epping Plains, or "Barrens," as they are called, lie between the Narraguagus and Pleasant rivers. They present a moderately rolling surface of sand, generally destitute of trees, except in the lower and swampy parts, and are traversed by sand ridges of different elevations, resembling very much the surface which the sounding line develops, in such regions as the Nantucket shoals, at present below the surface of the water.

The plain is quite elevated and falls suddenly from an irregularly curved margin, by a steep slope to a lower plain or wide valley.

Portions of the plain are strewed with boulders of various sizes, some of them containing not less than 4000 cubic feet, and of various granitic materials. Schoodiac Hill was found to limit the position of the base, so that the problem became to draw the longest line through a point at the base of that hill, the ends of which would be easily visible from the secondary and primary stations.

Before the final selection of the line a topographical survey was made under the direction of Assistant C. O. Boutelle, by

Sub-assistant J. A. Sullivan and Mr. Webber, and the profile was studied upon a sketch of the plain made by Lieut. Clark.

In 1856 I examined the site, and took steps to obtain the necessary estimates of the cost of preparing it for measurement. The profile of the line as graded gives a good general idea of the ground as it varied but little from the natural profile. (See sketch.)

The whole length of the line is about 8719 meters or 5·4 miles. Its general direction is E. 16° S. (*true bearing.*)

From the eastern end for about four miles the plain is quite level, rising in the first mile pretty regularly about fifteen feet, descending nearly as much in the next to rise by the same quantity in the third mile. It then runs along an elevated level for a fourth of a mile and descends gradually to the rougher part of the base which is included between the 3¾ miles from the east end and the western end of the base.

This line was skillfully graded by Mr. Boutelle, so as to follow the natural surface when the grade did not run above three degrees, and to give as long slopes as possible of the same grade for the convenience of measuring. (See sketch.)

As it was found more economical to make the temporary embankments than to excavate, a profile giving a considerable excess of embankment was selected.

This was executed in the cheapest way which would give stability for the time during which it was required to stand. The least width was twelve feet, of which nine feet was on the south and three feet on the north side of the line to be measured. The base was very carefully aligned. High signals were placed over the termini which are inter-visible. On the Schoodiac a signal of moderate elevation is visible from both, and the distances between this point and the termini were gradually subdivided, until the smallest limit, the distance easily reached by a small transit, was obtained.

The verification of the alignment at different points of the measurement when the seeing was good was complete.

In all these preliminary operations Mr. Boutelle was assisted by Sub-assistant J. A. Sullivan and Mr. Webber.

His grading partly consisted of the farmers and lumbermen of the district who served with great cheerfulness and skill in the use of the heavy implements for rough grading. One of the greatest difficulties was the removal of such boulders as were in the line, many of them being of such size as to require blasting to break them up, and some being actually removed to the required distance from the line by heavy blasts.

The signals erected at the two ends are very substantial, each forty-three feet in height to the top of the tripod and fifty-three to the cone which surmounts them.

The base apparatus already described before the Association, and described and figured in my report for 1854 by Lieut. E. B. Hunt of the Corps of Engineers, was used in this measurement, preliminary trials being made in the office to test its steadiness under the greatest inclination to which it would be subjected, and the accuracy of the surface upon which the measuring stem traverses and which determines the length of the apparatus.

I was assisted in the measurements by Assistant G. W. Dean, Prof. Fairman Rogers, who volunteered for the purpose, Sub-assistants Goodfellow, Stephen Harris and Sullivan, and Mr. Thomas McDonnell, among whom the different operations were divided.

The usual comparisons of the apparatus with the standard six metre bar, were made before and after the measurement to ascertain that no change had taken place in the length from damage by transportation, and to add to the results of former comparisons.

The measurement was begun at the west end of the line on Saturday the 18th of July, but the next week proved so rainy that it was only resumed in earnest on Monday the 27th.

The work of the first Saturday (24 tubes) was remeasured on the following Monday with precisely the same result as to length, the end of the second measurement falling on the marks which had been placed as terminating the first, and which were fine dots upon the head of a copper nail, placed in a stake some eighteen inches in length driven into the ground until its head just projected above the surface. The position of the mark was determined and verified, as all others of the sort in our measurements, by using a transit placed at right angles to the line and at a moderate distance from it. This was on a descending slope of the strongest grade adopted and there was a difference of temperature of some five degrees in the two measurements.

On Tuesday a length of eighteen tubes, which had been measured on Monday was remeasured with an identical result. This was on an ascending slope. On Monday the work was in part interrupted by the arrangements for photographing the apparatus, on Tuesday by a fog, and on Wednesday by showers in the beginning of the day: we made however half a mile on both days.

On Wednesday began a series of four unbroken days, during the first of which we measured about seven-eighths of a mile, and on the three others a mile, or more than a mile, each day, reaching the east end of the base on Monday evening. Thus counting in the broken days, 5·4 miles were measured in eight days.

This time included the marking of five permanent points near to the ends of the successive miles, where stone posts have since been placed. The ends of the base will be marked by regular monuments. The base of the monument at the west end is cut from the ledge of rocks upon which the signal stands.

By the kindness of Prof. Fairman Rogers I have been enabled to collect approximately some of the statistics of the measurement in a tabular form (No. I). A second table contains the comparison with the other five Coast Survey bases which I have measured.

EPPING BASE.—TABLE I.

Whole length of base in tubes, - - -	1453
" " " " " metres, - - -	8718^{m}
1^{m}4245 added at east base making - -	8719^{m}4245
or 28,607 feet, or about 5·4 miles.	
Diff. of level between highest and lowest points, -	104 ft. nearly.
Mean level of Base above mean tide, - -	257 ft. or 78^{m}43
Approx. corr. for reduction to the level of the sea, -	0^{m}·10714422
or 4 inches nearly.	
No. of tubes inclined, - - - - - -	643
" " " level, - - - - - - -	810
Ratio of tubes inclined to whole number, -	0·442 nearly.
" " " level " " " - -	0·550
Correction for versed sine for whole base, -	2^{m}·8038437
or 9·2 ft. to be subtracted.	

			Ratio to whole number inclined.
Maximum inclination,	3° 14′		
Number of tubes inclined,	3° and over	31	0·048
" " " "	2 30′ " "	234	0·364
" " " "	2 " "	79	0·123
" " " "	1 30 " "	120	0·186
" " " "	1 " "	110	0·171
" " " "	0 30 " "	21	0·032
" " " "		48	0·074
		643	

Greatest day's work 281 tubes 1·05 mile in 11^{h} 10^{m} working time.
Averaging 1 tube in 2^{m} 27^{s}.
Greatest number in one hour 37, or 1^{m} 37^{s} for each tube.

TABLE II.

Comparative Table of the Measurements of six U. S. Coast Survey Bases.

	Dauphine Island.	Bodies Island.	Edisto Island.	Key Biscayne	Cape Sable.	Epping Plains.
Whole No. of tubes measured,	1777	1807	1787	965	1072	1453
" " days employed,	17	10	13	9	8	8
" " hours "	148 17	31^{h} 08^{m}	97 28	66^{h} 31^{m}	46^{h} 26^{m}	69 43^{m}
" " tubes level,	961	1496	862	473	994	810
" " " inclined,	816	311	925	492	78	643
Ave'ge length of working day,	8^{h} 25^{m} 7	8^{h} 07^{m}	7^{h} 30	7^{h} 23^{m}	5^{h} 48^{m} 18^{s}	10^{h} 07^{m}
" time of one tube,	5^{m} 32	2^{m} 54^{s}	3^{m} 22^{s}	4^{m} 20^{s}	2^{m} 51^{s}	2^{m} 58^{s}
" No. of tubes per day,	104·5	180·7	137 5	107·2	134	181·6
" No. of tubes pr. d'y of 9^{h},	108·0	197·9	165 9	130 0	200·0	187·2
" " " " " hour,	11·85	21·98	18·[illegible]0	14·40	22·47	20 8
" plus inclination,	17′·6	16′·1	24′·5	31′·0	12′·0	1° 53′
" minus "	16′·6	19′·6	23′·0	26′·0	10′·0	1° 54′
" of greatest plus inclin.	40′·8	23′·7	55′·4	58′ 0	14′·0	2° 52′
" " " minus "	42′·6	29′·5	48′·4	54′ 0	11′·0	2° 46′
" temperature Fahr.	84° 5	52° 0	59° 5	82° 9	87° 9	70° 0′

The photographs of the apparatus and operations which I submit to the Association, were taken by Mr. Black, of the firm of Whipple and Black, Boston, who exerted himself especially in the matter and succeeded, under many disadvantages, from variable weather and the roughness of field arrangements for photography, in making satisfactory representations.

The views of the apparatus and operations (see Plate) include the placing of the apparatus over a mark, the aligning, the setting of the trestles in advance of the measurement, the transfer of the measuring tube and the making of contact.

The comparing apparatus and tent are also shown (see Plate lettered No. 1, Plans, Sections and Profile). One of the sketches shows the topographical features of the ground, and another gives the profile of the base as graded for measurement.

ART. IX.—*On the Influence of Musical Sounds on the Flame of a Jet of Coal-gas;* by JOHN LECONTE, M.D., Professor of Natural Philosophy in the South Carolina College.

A SHORT time after reading Prof. John Tyndall's excellent article "On the Sounds produced by the Combustion of Gases in Tubes,"* I happened to be one of a party of eight persons assembled after tea for the purpose of enjoying a private musical entertainment. Three instruments were employed in the performance of several of the grand trios of Beethoven, namely, the piano, violin, and violoncello. Two "*fish-tail*" gas-burners projected from the brick wall near the piano. Both of them burnt with remarkable steadiness, the windows being closed and the air of the room being very calm. Nevertheless it was evident, that *one* of them was under a pressure nearly sufficient to make it *flare.*

Soon after the music commenced, I observed that the flame of the last-mentioned burner exhibited pulsations in height, which were *exactly synchronous* with the audible beats. This phenomenon was very striking to every one in the room, and especially so when the strong notes of the violoncello came in. It was exceedingly interesting to observe how perfectly even the *trills* of this instrument were reflected on the sheet of flame. *A deaf man might have seen the harmony.* As the evening advanced, and the diminished consumption of gas in the city *increased the pressure*, the phenomenon became more conspicuous. The *jumping* of the flame gradually increased—became somewhat irregular—and finally it began to flare continuously, emitting the characteristic sound indicating the escape of a greater amount of gas than

* *Vide* Philosophical Magazine, 4th Series, vol. xiii, p. 473, 1857.

ould be properly consumed. I then ascertained by experiment, hat the phenomenon *did not* take place unless the discharge of ;as was so regulated that the flame approximated the condition f *flaring*. I likewise determined by experiment, that the effects vere *not* produced by jarring or shaking the floor and walls of he room by means of repeated concussions. Hence it is obvious, that the pulsations of the flame *were not* owing to *indirect* vibrations propagated through the medium of the walls of the oom to the burning apparatus, but must have been produced by he *direct* influence of the aerial sonorous pulses on the burning jet.

In the experiments of M. Schaffgotsch and Prof. J. Tyndall, it is evident that "the shaking of the singing flame within the glass tube," produced by the voice or the syrene, was a phenomenon perfectly analogous to what took place under my observation *without the intervention of a tube*. In my case, the discharge of gas was so regulated that there was a tendency in the flame to flare, or to emit a "*singing sound*." Under these circumstances, strong aerial pulsations occurring at *regular intervals*, were sufficient to develop synchronous fluctuations in the height of the flame. It is probable that the effects would be more striking when the tones of the musical instrument are *nearly* in unison with the sounds which would be produced by the flame under he slight increase in the rapidity of discharge of gas required o manifest the phenomenon of flaring. This point might be submitted to an experimental test.

As in Prof. Tyndall's experiments on the jet of gas burning within a tube, clapping of the hands, shouting, etc. were ineffecual in converting the "silent" into the "singing flame,"—so, in he case under consideration, *irregular* sounds did not produce any perceptible influence. It seems to be necessary that the impulses should *accumulate* in order to exercise an appreciable ffect.

With regard to the mode in which the sounds are produced y the combustion of gases in tubes, it is universally admitted, hat the explanation given by Prof. Faraday in 1818 is essentially orrect. It is well known that he referred these sounds to the uccessive explosions produced by the periodic combination of he atmospheric oxygen with the issuing jet of gas. While eading Prof. J. Plateau's admirable researches (third series) on he "Theory of the modifications experienced by Jets of Liquid ssuing from circular orifices when exposed to the influence of Vibratory Motions,"* the idea flashed across my mind that the henomenon which had fallen under my observation, was nothing nore than a *particular case* of the effects of sounds on *all kinds*

* Philosophical Magazine, 4th series, vol. xiv, p. 1 et seq., July, 1857.

of fluid jets. Subsequent reflection has only served to fortify this first impression.

The beautiful investigations of Felix Savart on the influence of sounds on jets of water, afford results presenting so many points of analogy with their effects on the jet of burning gas, that it may be well to inquire whether both of them may be referred to a common cause. In order to place this in a striking light, I shall subjoin some of the results of Savart's experiments. Vertically descending jets of water receive the following modifications under the influence of vibrations:—

1. The continuous portions become shortened; the vein resolves itself into separate drops nearer the orifice, than when *not* under the influence of vibrations.

2. Each of the masses, as they detach themselves from the extremity of the continuous part, becomes flattened alternately in a vertical and horizontal direction, presenting to the eye, under the influence of their translatory motion, regularly disposed series of maxima and minima of thickness, or ventral segments and nodes.

3. The foregoing modifications become much more developed and regular, when a note, in unison with that which would be produced by the shock of the discontinuous part of the jet against a stretched membrane, is sounded in its neighborhood. The continuous part becomes considerably shortened, and the ventral segments are enlarged.

4. When the note of the instrument is *almost* in unison, the continuous part of the jet is alternately lengthened and shortened, and the beats which coincide with these variations in length *can be recognized by the ear.*

5. Other tones act with less energy on the jet, and some produce no sensible effect.

When a jet is made to ascend *obliquely*, so that the discontinuous part appears scattered into a kind of *sheaf* in the same vertical plane, M. Savart found:—

a. That under the influence of vibrations of a determinate period, this sheaf may form itself into *two* distinct jets, each possessing regularly disposed ventral segments and nodes; sometimes, with a different note, the sheaf becomes replaced by *three* jets.

b. The note which produces the greatest shortening of the continuous part, always reduces the whole to a *single jet*, presenting a perfectly regular system of ventral segments and nodes.

In the last memoir of M. Savart—a posthumous one—presented to the Academy of Sciences of Paris by M. Arago in 1853,* several remarkable acoustic phenomena are noticed in

* Comptes Rendus for August 1853. Also Phil. Mag., 4th series, vol. vii, p. 186, 1854.

ation to the musical tones produced by the efflux of liquids rough short tubes. When certain precautions and conditions ꜫ observed (which are minutely detailed by this able experi-entalist), the discharge of the liquid gives rise to a succession musical tones of great intensity and of a peculiar quality, some-ıat analogous to that of the human voice. That these notes ere not produced by the descending drops of the liquid vein, as proved by permitting it to discharge itself into a vessel of ater, while the orifice was below the surface of the latter. In is case, the jet of liquid must have been *continuous*, but never-eless the notes were produced. These unexpected results have en entirely confirmed by the more recent experiments of Prof. yndall.*

According to the researches of M. Plateau, all of the phe-omena of the influence of vibrations on jets of liquid, are re-rable to the conflict between the vibrations and the *forces of gure* ("*forces figuratrices*"). If the physical fact is admitted,—nd it seems to be indisputable,—that a liquid cylinder attains a *mit of stability* when the proportion between its length and its iameter is in the ratio of twenty-two to seven, it is almost a *hysical necessity* that the jet should assume the constitution indi-ıted by the observations of Savart. It likewise seems highly robable that a liquid jet, while in a transition stage to discon-nuous drops, should be exceedingly sensitive to the influence all kinds of vibrations. It must be confessed, however, that lateau's beautiful and coherent theory does not appear to em-race Savart's last experiment, in which the musical tones were oduced by a jet of water issuing under the surface of the same quid. It is rather difficult to imagine what agency the "forces figure" could have, under such circumstances, in the pro-ıction of the phenomenon. This curious experiment tends to orroborate Savart's original idea, that the vibrations which oduce the sounds must take place in the glass reservoir itself, ıd that the cause must be inherent in the phenomenon of the ɔw.

To apply the principles of Plateau's theory to gaseous jets, we e compelled to abandon the idea of the *non-existence of molecu-r cohesion in gases.* But is there not abundant evidence to ıow that cohesion *does exist* among the particles of gaseous asses? Does not the deviation from rigorous accuracy both in ıe law of Mariotte and of Gay-Lussac,—especially in the case condensable gases, as shown by the admirable experiments M. Regnault,—clearly prove, that the hypothesis of the non-cistence of cohesion in aeriform bodies is fallacious? Do not e expanding rings which ascend when a bubble of phosphu-

* Philosophical Magazine, 4th series, vol. viii, p. 74, 1854.

retted hydrogen takes fire in the air, indicate the existence of some cohesive force in the gaseous product of combustion (aqueous vapor), whose outlines are marked by the opake phosphoric acid? In short, does not the very *form* of the flame of a "fish-tail" burner demonstrate that cohesion *must exist* among the particles of the issuing gas? It is well known that, in this burner, the single jet which issues is formed by the union of *two oblique jets* immediately before the gas is emitted. The result is a perpendicular *sheet of flame.* How is such a result produced by the mutual action of two jets, unless the force of cohesion is brought into play? Is it not obvious, that such a fan-like flame must be produced by the same causes as those varied and beautiful forms of aqueous sheets developed by the mutual action of jets of water, so strikingly exhibited in the experiments of Savart and of Magnus?

If it be granted that gases possess molecular cohesion, it seems to be physically certain, that jets of gas must be subject to the same laws as those of liquid. Vibratory movements excited in the neighborhood, ought, therefore, to produce modifications in them analogous to those recorded by M. Savart in relation to jets of water. Flame or incandescent gas presents gaseous matter in a *visible* form, admirably adapted for experimental investigation; and *when produced by a jet*, should be amenable to the principles of Plateau's theory. According to this view, the pulsations or *beats* which I observed in the gas-flame when under the influence of musical sounds, are produced by the conflict between the aerial vibrations and the "forces of figure" (as Plateau calls them), giving origin to periodical fluctuations of intensity, depending on the sonorous pulses.

If this view is correct, will it not be necessary for us to modify our ideas in relation to the agency of tubes in developing musical sounds by means of burning jets of gas? Must we not look upon all burning jets,—as in the case of water-jets,—as *musically inclined;* and that the use of tubes merely places them in a condition favorable for developing the tones? It is well known, that burning jets frequently emit a *singing sound* when they are perfectly *free.* Are these sounds produced by successive explosions analogous to those which take place in glass tubes? It is very certain, that under the influence of molecular forces, any cause which tends to elongate the flame, without affecting the velocity of discharge, must tend to render it discontinuous, and thus bring about that mixture of gas and air which is essential to the production of the explosions. The influence of tubes as well as of aerial vibrations in establishing this condition of things is sufficiently obvious. Was not the "beaded line" with its succession of "luminous stars," which Prof. Tyndall observed when a flame of olefiant gas burning in a tube, was examined by means

of a moving mirror, an indication that the flame became *discontinuous*, precisely as the continuous part of a jet of water becomes *shortened*, and resolved into isolated drops, under the influence of sonorous pulsations? But I forbear enlarging on this very interesting subject, inasmuch as the accomplished physicist last named, has promised to examine it at a future period. In the hands of so sagacious a philosopher, we may anticipate a most searching investigation of the phenomena in all their relations. In the mean time, I wish to call the attention of men of science to the view presented in this article, in so far as it groups together several classes of phenomena under one head, and may be considered a partial generalization.

Columbia, South Carolina, Oct., 1857.

ART. X.—*On the Motion of the Gyroscope as modified by the retarding forces of friction and the resistance of the air: with a brief analysis of the "Top;"* by Maj. J. G. BARNARD, A. M., Corps of Engineers, U. S. A.

IN a previous paper (see article in this Journal for July, 1857, to which this paper is intended to be supplementary,) I have investigated the "Self-sustaining power of the Gyroscope" in the light of analysis. From the general equations of "Rotary motion" I have deduced the laws of motion for the particular case of a *solid of revolution* moving about a fixed point in its axis of figure, (or the prolongation thereof). I have shown that such a body, having its axis placed in any degree of inclination to the vertical, and having a high rotary motion about *that axis*, will not, under the influence of gravity, *sensibly fall;* but that any point in the axis will describe "an undulating curve whose superior culminations are *cusps* lying in the same horizontal plane;" that this curve approaches more and more nearly to the cycloid, as the velocity of axial rotation is greater; that when this velocity is very great the undulations become very minute and "the axis of figure performing undulations too rapid and too minute to be perceived, moves slowly about its point of support." I have shown how the direction and velocity of this *gyration* are determined by the direction and velocity of axial rotation and the distance of the center of gravity of the figure from the point of support, and that the remarkable phenomenon exhibited by the gyroscope is but a *particular case* due to a *very high velocity* of axial rotation, of the general laws of motion of such a body as described, which embrace the motion of the pendulum in one extreme and that of the gyroscope in the other, and that intermediate between

these two extreme cases (for moderate rotary velocities) the undulations of the axis, will be large and sensible.

I have likewise shown that whenever, to the axis of a rotating solid, an angular velocity is imparted, a force which I have called "*the deflecting force*" acting perpendicular to the plane of motion of that axis, is developed, whose intensity is proportional to this angular velocity, and likewise to the rotary velocity of the body; and that it is this *deflecting force* which is the immediate *sustaining agent*, in the gyroscope.

In the above deductions of analysis is found the full and complete solution of the "self-sustaining power of the gyroscope."

To make the character of the motion indicated by analysis, sensible to the eye, it is only necessary to attach to the ordinary gyroscope, in the prolongation of the axis, an arm of five or six inches in length, and having an universal joint at its extremity, and to swing the instrument as a pendulum; or, the extremity of an arm of such a length may be rested in the usual way, upon the point of the standard, when, with the centre of gyration removed at so great a distance from the point of support, the undulatory motion becomes very evident.

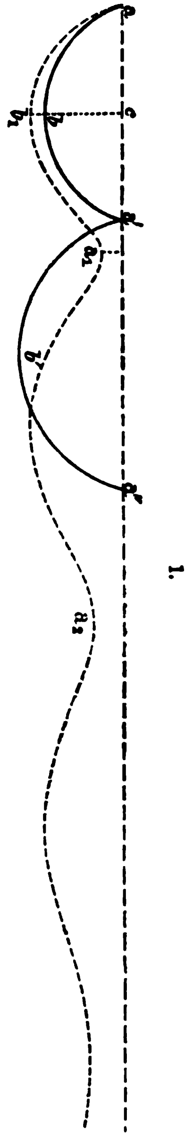
But it cannot fail to be observed that the motion preserves this peculiar feature but for a very short period. The undulations speedily disappear; instead of periodical moments of *rest* (which the theory requires at each *cusp*) the gyratory velocity becomes *continuous*, and nearly uniform and horizontal; and it increases as the axis (owing to the retarding influences of friction and the resistance of the air) slowly falls. In short, the axis soon seems to move upon a descending spiral described about a vertical through the point of support.

The experimental gyroscope, in its simplest form consists of two distinct masses, the rotating disk, and the *mounting* (or ring in which the disk turns). The point of support in the latter, though it gives free motion about a vertical axis, constrains more or less, the motion of the combined mass about any other. The rotating disk turns at the extremities of its axle, upon points or surfaces in the mass of the mounting, *with friction;* it is rare, too, that the point of support, of the mounting, is adjusted in the exact prolongation of the axis of the disk.

Without attempting to subject to analysis causes so difficult to grasp as these, I shall first attempt to show, by general considerations, what would be the *immediate* influence of the retarding forces of friction and the resistance of the air upon our theoretical solid; and then point out the further effect due to the discrepancies of figure, above indicated. Leaving out of consideration the minute effect of friction at the point of support, these forces exert their influence, mainly in retarding the *rotary velocity of the disk.* Friction—at the extremities of the axle of

sk, and the resistance of the air, at its surface, are power-ough to destroy entirely in a very few minutes, the high ty originally given to it. It is in this way, mainly, that nodify the motion indicated by analysis.

he rotary velocity remained *constant* while cis made *one* of the little cycloidal curves (fig. 1) the deflecting force would be just ent, as I have shown (p. 68 of the article to lift the axis back to its original ele-ı a', and to destroy, *entirely*, the velocity l acquired through its fall cb. If, at a', otary velocity n underwent an *instanta-* diminution, and remained constant gh another undulation, a curve, of larger tude and sagitta $a'b'a''$ would be de-d, and the axis would *again* rise to its al elevation a'', and *again* be brought to We might then, on casual considera-of the subject, expect to see the undula-become more and more sensible as the r velocity decreased. The reverse, how-is the case, as I have already stated. In he above supposition would require the r velocity n to be a *discontinuous* decreas-ınction of the time; whereas it is, really *inuous* decreasing function. It is under-a gradual diminution between a and a'. *leflecting force,* which is constantly pro-ınal to it, is *therefore* insufficient to keep cis up to the theoretical curve aba', but r curve ab_1a_1 is described; and when ılmination a_1 is reached, it is *below* the ıal elevation a'.



t the 2d of our general equations for the cope (4), [afterwards put under the sim-orm (eq. (f)) $v_s{}^2 = \frac{2g}{\gamma}h$] which is *inde-nt of n*, shows that the angular velocity : axis will always be that due to its *actual* below the initial elevation. On reaching ılmination a_1 therefore, the axis will not to rest, but will have a horizontal veloc-ıe to the fall $a'a_1$ and the curve will not a *cusp* but an *inflexion* at a_1.

e axis will commence its second descent, fore, with an *initial horizontal velocity.* ll not descend as much as it would have

done had it started *from rest* with its diminished value of n; and, for the same reason as before, will not be able to rise again as high as its starting point a_1 but to a somewhat lower point a_2 and with an increased horizontal velocity. These increments of horizontal velocity will constantly ensue as the culminations become lower and lower, while on the other hand, the undulations become less and less marked, as indicated by the figure.

I have stated in my former paper (p. 71) that a certain *initial* horizontal angular velocity such as would "make its corresponding deflecting force equal to the component of gravity, $g \sin \theta$, would cause a horizontal motion without undulation." This horizontal velocity is rapidly attained through the agencies just described: or, at least, nearly approximated to, and the axis, as observation shows, soon acquires a continuous and uniform horizontal motion.

On the other hand, this sustaining power being directly proportional to the rotary velocity of the disk, as well as to the angular velocity of the axis, diminishes with the former, and as it diminishes, the axis must descend, acquiring angular velocity due to the height of fall: hence the rapid gyration and the descending spiral motion which accompanies the loss of rotary velocity.

A more curious and puzzling effect of the friction of the axle is presented, when we come to take into consideration, instead of our theoretical solid, the discrepancies of figure presented by the actual gyroscope. If, with a high initial rotation, the common gyroscope be placed on its point of support with its axis somewhat inclined *above* a horizontal position, it will soon be observed to *rise*. In my analytical examination (p. 55) I have stated as a deduction from the second equation (4), that "the axis of figure can never rise *above* its initial angle of elevation." That equation supposes that the rotary velocity n *remains unimpaired*, and is the expression of a fundamental principle of dynamics—that of "living forces" (so-called), which requires that the living force generated by gravity be directly proportional to the height *of fall*, and involves as a corollary that through the agency of its own gravity alone, the centre of gravity of a body can never rise above its initial height.* The anomaly observed, therefore, either requires the action of some *foreign force; or*, that the living force lost by the rotating disk, shall, through some hidden agency, be expended in performing this work of *lifting* the mass.

* The first of these equations (as I have remarked in a note to p. 59) is the expression of another fundamental principle—more usually called the "principle of areas."

e discrepancy here exhibited between the motion proper to heoretical solid of revolution and the experimental gyro- is due to the division of the latter into two distinct masses, f which rotates, *with friction,* upon points or surfaces in the ; and to the fact that at the point of support (in the latter) is not *perfectly free motion* in all directions.

e friction at the extremities of the axle of the disk, tends press on the mass which constitutes the "mounting," a ro- ı in the same direction. Were the motion of the latter its fixed point of support *perfectly free,* the mounting and would soon acquire a *common rotatory velocity* about the of the disk. But the mounting *is* perfectly free to turn t the *vertical* axis through the point of support, though *not any other.* If we decompose, therefore, the rotation which d be impressed upon the mounting into two components, bout this vertical, and the other about a horizontal axis— rst takes *full effect,* and the latter is destroyed at the point pport. If the axis of the instrument is *above* the horizon- his component of rotation is in the same direction as the *ion* due to gravity, and *adds to it;* if the axis is *below* the ontal, the component is the reverse of the natural gyration, *liminishes it.*

.t I have shown that the axis soon acquires, independent of ;ause, a gyration whose deflecting or sustaining force is just ralent to the downward component of gravity. The *addi-* o this gyratory velocity caused by friction when the axis is ıed *upwards* puts the deflecting force in *excess,* and the axis sed; it is raised, as in all other cases in which *work* is done ıgh acquired velocity—viz., by an expenditure of *living* : but in this instance, through a most curious and compli- series of agencies.

ıe phenomenon may be best illustrated in the following man- Let the outer extremity of the common gyroscope, having cis inclined *above* the horizontal, be supported by a thread hed to some fixed point vertically above the point of support, at gyration shall be free. Here gravity is eliminated, and .xis of our theoretical solid of revolution would remain per- 7 motionless; but the gyroscope starts off, of itself, to gy- in *the same direction* that it would were its extremity *free.* gyration increases (if the rotary velocity is great) until the cting force due to it, lifts the outer extremity from its sup- on the thread, and it continues indefinitely to rise. Try same experiment with the axis *below* the horizontal. The tion will commence spontaneously as before, but in the *se* direction: it will increase until the *inner extremity is lifted the point of support,* (the action of the deflecting force being reversed,) the instrument supporting itself on the thread

alone. If the experiment is tried with the axis perfectly horizontal, no gyration takes place, for the component of rotation, due to friction, is, in this position, zero.

The foregoing reasoning accounts, I believe, for all the observed phenomena of the experimental gyroscope, and shows how, from the theory of our imaginary solid of revolution, a consideration of the effects of the discrepancies of form, and of the actual disturbing forces, leads to their satisfactory explanation.

The great similarity between the phenomena of the top and gyroscope, renders it not uninteresting to compare the laws of motion of the two. If we conceive a solid of revolution terminated at its lower extremity by a *point* (the ordinary form of the top), resting upon a horizontal plane without friction, *and having a rotary motion about its axis of figure*, such a body will be subject to the action of two forces; *its weight*, acting at the centre of gravity, and the *resistance of the plane*, acting at the point vertically upwards.

According to the fundamental principles of dynamics, the centre of gravity will move as if the mass and forces were concentrated at that point, while the mass will turn about this centre as if it were fixed. Calling R the resistance of the plane, M the mass, and Mg the weight of the top, and z the height of the centre of gravity above the plane, we shall have for the equation of motion of the centre of gravity*

$$M\frac{d^2z}{dt^2}=R-Mg \qquad (1.)$$

As the angular motion of the body is the same as if the centre of gravity was fixed, and as R is the only force which operates to produce rotation about that centre, if we call C the moment of inertia of the top about its axis of figure, and A its moment with reference to a perpendicular axis through the centre of gravity, and γ the distance, GK (fig. 2) of the point of support from that centre; the equations of rotary motion will become identical with equations (3) (p. 53),† substituting R for Mg

$$\left.\begin{array}{l} C\,dv_z=0 \\ A\,dv_y-(C-A)\,v_z v_x dt=\gamma a R dt \\ A\,dv_x+(C-A)\,v_y v_z dt=-\gamma b R dt \end{array}\right\} \qquad (2.)$$

The first of equations (2) gives us v_z as for the gyroscope, equal a constant n.

Multiplying the 2d and 3d of equations (2) by v_y and v_x respectively, and adding and making the same reduction as on p. 53, we shall get

$$A(v_y dv_y+v_x dv_x)=R\gamma d.\cos\theta.$$

* As there are no horizontal forces in action, there can be no horizontal motion of the centre of gravity except from initial impulse, which I here exclude.

† The references throughout this paper are to my paper on the gyroscope in the July number of this Journal.

But z (the height of the centre of gravity above the fixed plane) $=-\gamma\cos\theta$; hence $\gamma d.\cos\theta=-dz$; and equation (1) gives $R=M\left(\frac{d^2z}{dt^2}+g\right)$. Substituting these values of R and $\gamma d.\cos\theta$ in the preceding equation, and integrating, we have

$$A(v_y{}^2+v_x{}^2)+M\left(\frac{dz^2}{dt^2}+2gz\right)=h \qquad (3.)$$

From the 2d and 3d of equations (2) the equation (c) (of the gyroscope, p. 54) is deduced by an identical process.

$$A(bv_y+av_x)+Cn\cos\theta=l,$$

and a substitution in the two foregoing equations of the values of the cosines a and b, and of the angular velocities v_x and v_y, in terms of the angles φ, θ and ψ (see pp. 52, 53), and for z and $\frac{dz}{dt}$ their values, $-\gamma\cos\theta$, and $\gamma\sin\theta\frac{d\theta}{dt}$, and a determination of the constants, on the supposition of an initial inclination of the axis α, and of initial velocity of axial rotation n, will give us for the equations of motion of the *top:*

$$\left.\begin{aligned}&\sin^2\theta\frac{d\psi}{dt}=\frac{Cn}{A}(\cos\theta-\cos\alpha)\\ &A\left(\sin^2\theta\frac{d\psi^2}{dt^2}+\frac{d\theta^2}{dt^2}\right)+M\gamma^2\sin^2\theta\frac{d\theta^2}{dt^2}=2Mg\gamma(\cos\theta-\cos\alpha)\end{aligned}\right\}(4.)$$

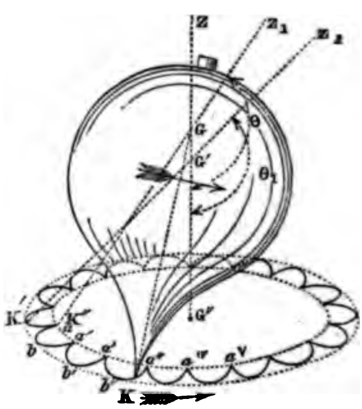
from which the angular motions of the top can be determined. The first is identical with the first equation (4) for the gyroscope. The second differs from the second gyroscopic equation only in containing in its first member the term $M\gamma^2\sin^2\theta\frac{d\theta^2}{dt^2}$, or its equivalent $M\frac{dz^2}{dt^2}$, expressing the living force of vertical *translation* of the whole mass.

The second member (as in the corresponding equation for the gyroscope) expresses the *work of gravity*, and the first term of the first member expresses the living force due to the angular motion of the axis. Instead therefore of the work of gravity being expended (as in the gyroscope) *wholly* in producing angular motion, part of it is expended in vertical translation of the centre of gravity. The angular motion takes place not (as in the gyroscope) about the point of support (which in this case is not *fixed*), but about the centre of gravity (to which the moments of inertia A and B refer); and that centre, motionless horizontally, moves vertically up and down, coincident with the small angular undulations of the axis through a space which will be more and more minute as the rotary velocity n is greater.

An elimination of $\frac{d\psi}{dt}$ between the two equations (4) and a study of the resulting equation, would lead us to the same general results, as the similar process, p. 56, for the gyroscope.

The vertical angular motion, expressed by the variation which the angle θ undergoes, becomes exceedingly minute (the maximum and minimum values of θ approximating each other) when n is great, and the axis gyrates with slow undulatory motion about a vertical through the centre of gravity. It would be easy, likewise, to show by substituting for θ another variable, $u=\alpha-\theta$, always (in case of high values of n) extremely small, and whose higher powers may therefore be neglected, that the co-ordinates of angular motion, u and ψ, approximate more and more nearly to the relation expressed by the equation of the cycloid as n increases; though the approximation is not so rapid as in the gyroscope. All the results and conclusions flowing from the similar process for the gyroscope (see pp. 57, 58, 59, 60) would be deduced. As, however, the centre of gravity, to which these angular motions are referred, is not a *fixed point*, but is itself constantly rising and falling as θ increases or diminishes, the actual motion of the axis is of a more complicated character.

2.



If GK'' (see fig. 2) is the initial position of the axis of the top, the motion of the centre of gravity will consist in a vertical falling and rising through the distance $GG'= GK''(\cos z_2\, G'G''-\cos z_1\, GG'') =\gamma(\cos\theta_1-\cos\alpha)$ (in which θ_1 is the *minimum* value of θ), while the extremity of the axis or *point*, K, describes on the supporting surface and about the projection G'' of the centre of gravity, an undulating curve a, b, a', b', a'', &c., having *cusps* a, a', &c., in the circle described about G'' with the radius $G''K''=\gamma\sin\alpha$, and tangent, externally, to the circle described with a radius $G''K'=\gamma\sin\theta_1$. But as in the case of the gyroscope, these little undulations speedily disappear through the retarding influence of friction and resistance of the air, and the point of the top describes a circle, more or less perfect, about G''.

The *rationale* of the self-sustaining power of the top is identical with that of the gyroscope; the *deflecting* force due to the

angular motion of the axis plays the same part as the sustaining agent, and has the same analytical expression. Owing to *friction*, the top likewise rises, and soon attains a vertical position; but the agency by which this effect is produced is not exactly the same as for the gyroscope.

If the extremity of the top is rounded, or is not a perfect mathematical point, it will *roll*, by friction, on the supporting surface along the circular track just described. This rolling speedily imparts an angular motion to the axis greater than the horizontal gyration due to gravity, and the deflecting force becomes in excess, (as explained in the case of the gyroscope,) and the axis rises until the top assumes a vertical position. Even though the extremity of the top is a very perfect *point*, yet if it happens to be slightly *out* of the axis of figure (and rotation) the same result will, in a less degree, ensue: for the point, instead of resting *permanently* on the surface, will *strike it*, at each revolution, and in so doing, propel the extremity along. The conditions of a *perfect point*, perfectly centered in the axis of figure, are rarely combined, or rather are *practically impossible;* but it is easy to ascertain by experiment that the more nearly they are fulfilled, and the harder and more highly polished the supporting surface, the less tendency to rise is exhibited; while the great *stiffness* (or tendency to assume a vertical position) of tops with rounded points, is a fact well known and made use of in the construction of these toys.

CORRECTION.

In the No. for July, 1857, vol. xxiv, No. 70, p. 65, 8th line of note, for "vertical," *read* "horizontal," and for "horizontal," *read* "vertical." 10th line, for "the first," *read* "the second."

Art. XI.—*Review of the Operations and Results of the United States Coast Survey.*

Though the annual reports of the United States Coast Survey have been frequently noticed in this Journal, no general or connected view of the progress of our greatest national scientific work has yet been given. The voluminous reports themselves, appearing as they do each year, filled with elaborate details and copiously illustrated by diagrams and charts, convey no adequate idea of the real magnitude and importance of the Survey. We are apt in the attentive and well repaying study of the details to lose sight of the unity of the whole. So many sciences are here pressed into service, and so many special results of absorbing interest are obtained, that the materials almost make us forget the size and the beauty of the edifice.

An organized being, said Kant, is that of which all the parts are mutually ends and means. We are forcibly reminded of the definition in studying the operations and results of the Coast Survey. All the results, in geography, in physics, in geology, in short in every branch of science, are at once means and ends: means, as they form necessary and integral parts of a great and symmetrical whole; ends, as they all possess a fixed and definite value in the sciences to which they belong. This remark, if true as applied to the Survey considered simply from a scientific point of view, is far more forcibly illustrated by the practical bearings of the work, every one of whose details has an immediate practical value, while the enduring, far-reaching utility of the whole is second to that of no other human undertaking.

It is our purpose in the following pages to offer a concise view of the operations and results of the Coast Survey, regretting only that the necessary limits of a scientific review will scarcely permit us to give more than an outline sketch.

The survey of a coast so extensive as that of the United States is even in its general features a work of immense extent. That coast stretches from New Brunswick to Mexico, and from the Straits of Fuca to Old California; upon the Atlantic and Gulf from the 24th to the 44th parallel; upon the Pacific from the 42d to the 50th. Within that range of more than 5000 miles it embraces every geographical peculiarity. Innumerable islands, bays, capes and headlands, line the long reach of shore. Sandbanks hundreds of miles in length, enclosing shallow half-inland sounds, and bays stretching far into the interior like Norwegian fiords, are among its most striking features. The Coast Survey must accurately locate every prominent point, map out the bottom of every bay and harbor, fix the bearings of every reef and shoal, trace the course of every current, deduce from long continued observations the laws of the tides, and in short, observe and measure every peculiarity in the physical geography of the coast which the most refined science, the most delicate methods of observation and the most perfect instrumental means can measure or detect.

After a preliminary reconnoissance, the Survey begins with the measurement of a base, that is to say, with the accurate determination of the length of a line upon the earth's surface, the two extremities of which shall serve as starting points. Setting out from these two initial points, the survey proceeds by great steps of thirty or forty miles till the whole coast is covered with a network of large triangles, constituting what is termed the primary triangulation. The angles only of these triangles are measured, the sides being successively calculated by the aid of the angles and base. The accurate measurement of this line involves the most delicate instrumental methods. The expansions,

nclinations, and flexures of the measuring bars, and the contacts of their extremities must be observed with exquisite nicety. Here at the very first step in the work, the science of physics is called upon for its indispensable aid, and the reflecting pyrometer measures the expansions of the bars with an accuracy which is almost without limit. Delicate levels give the corrections for the inclinations and flexures, while the contact level determines the contacts of the successive bars. To such a degree of perfection have the measurements been brought that the probable error in determining the length of a base five miles in length does not under favorable circumstances exceed a few tenths of an inch. The base line being measured, the triangulation begins. Signals at distances of ten to twenty miles from either end of the base are observed in succession, and their angular distances determined with all the precision which modern mechanism has given the theodolite. The sides of the great triangles thus obtained being calculated, the signals form themselves fixed points for new angular measurements, and so the triangulation stretches from hill to hill till the prominent points of the entire coast are determined. The signals themselves are of no small interest. Bright tin cones mounted upon poles are often used, and reflect to a distance a brilliant line of solar light. But of all signals, the heliotrope—a movable mirror placed so as to be directed by a telescope—is the most perfect. With this instrument, the sun's rays have been reflected so as to be distinctly seen with a telescope at the distance of more than one hundred thousand yards. It is easy to see that, as the triangulation extends, the small errors inseparable from every physical measurement may accumulate so that the positions of the stations most remote from the base line may be incorrectly determined. Two methods are adopted to guard against errors of this kind. A subsidiary base line may be measured near the terminal signals of the primary triangulation, and from the extremities of this we may work backwards, so as to check the results of the first series of observations and calculations of distances. The geographical positions of the principal stations may themselves be determined by accurate astronomical observations, assigning their exact latitudes and longitudes, to check the calculated positions. Both these methods have been brought almost to perfection, but the latter has been especially fertile in new and beautiful results.

It is easy to see that while the bases and triangles give distances, the observations of latitude and the azimuths give differences of longitude by the aid of spheroidal formulas, a central longitude having been once determined. The differences of longitude are in their turn checked by the telegraph operations to which we shall presently allude.

The base which serves as the commencement of the primary triangulation for the eastern and middle states lies within the state of Massachusetts, a little to the north of Rhode Island. Its length is over ten miles and its direction nearly northeast and southwest: it was measured in 1845. Surveys for a verification base have been made in the northeastern part of the state of Maine, on Epping Plains. Since the commencement of the survey not less than nine primary and thirty-five secondary bases have been measured, making a total length of about 135 miles.

As the different stations of the primary triangulation are at different heights, it is necessary to measure vertical as well as horizontal angles, and finally, in consequence of the spheroidal figure of the earth, to reduce the plane triangles, which are the direct results of the measurements, to spheroidal triangles, at the level of the sea. In this manner after immense labor, both of observation and of calculation, the positions of the primary stations are at length fixed, and these now serve as starting points for the secondary triangulation which determines the general outline of the coast in detail, and the positions of rocks, reefs, and islands. The triangles observed are now smaller but very much more numerous, and the labor of observation and reduction even greater than before. Then comes the topography of the coast, the work at every successive step running more and more into detail. The coast line is now traced and laid down in charts of elaborate minuteness and finish. Harbors are surveyed and mapped out by innumerable soundings; the exact character and value of each being determined. The nature of the bottom with reference to anchorage, the depth and direction of channels, currents, tides and prevalent winds, the proper position of lighthouses, buoys and fog-bells, all form subjects of special and minute attention. In this manner the entire coast from Mt. Desert island to Cape Fear has been almost completely surveyed, and that portion of the sea-coast may be regarded as nearly finished. But beside the bays, harbors, and sounds of the coast, the rivers receive their share of attention, small triangulations being carried up to the head of tide waters, based upon one of the sides of the larger work. In this manner the river shores are accurately mapped, while careful soundings determine the bars and channels. The mouths of the larger rivers offer special subjects of examination of the highest interest and importance. We refer to the changes in the depth and position of the channels produced by the effects of currents. The characteristics of the delta of the Mississippi, and the enormous quantities of matter annually brought down by the current are too familiar to require notice in this place, but the changes in the entrance to the harbor of New York have not until very recently attracted attention to the same degree.

[he extension of docks and piers into the North and East ers, and the amount of new made land, excited such serious rm in the mercantile community that a Board of Harbor nmissioners was appointed in the year 1855 to consider the ole subject and devise means for averting the impending ıger. To the action of that Board the assistance of the ıst Survey was cheerfully and gratuitously rendered, and the ults of the survey and of a careful and accurate examination the effects of wharves and piers upon harbor currents, have :n of the greatest importance to the commercial prosperity of : city. Another very important observation has been made the existence of a slowly moving northwardly current on th sides of Sandy Hook, tending by deposits of sand to nar- r the main ship channel. For the action of this current the rvey provides a remedy which can be applied as soon as it ıll become necessary.

We have already stated that the assistance of astronomical ervations is needed in the operations of the primary trian- lation. The special objects of the Survey and the peculiar ıracter of the work done by it, have in their turn exercised a aarkable influence upon astronomy itself, considered at least a science of observation. New methods for the determination latitudes and longitude have had their origin in the necessi- ; of the Coast Survey alone, while the methods already own and practised have been developed and perfected. Spe- l series of observations have been undertaken at the two ervatories of Cambridge, Mass., and at numerous minor tions, to obtain the astronomical data requisite for the deter- ıation of differences of longitude, while the genius of the st eminent mathematician whom our country has produced, ; been devoted to the perfecting of the methods of reduction l calculation.

The determination of differences of longitude by means of the :tric telegraph—a method which doubtless suggested itself to usands, when the telegraph passed from an idea to a reality— s first carried out properly by the Coast Survey. This method ; not merely yielded results of great value to the survey :lf, but the particular mode of applying it has been general- d into the American method of recording astronomical obser- ions, and of measuring minute intervals of time. This thod has been adopted in several European observatories:— all but one with an honorable acknowledgment of its origin.

The experiments of Mr. Wheatstone made in 1834 with paratus devised and executed by Mr. Saxton, gave the first ermination of the velocity of electricity in a metallic con- ctor. This velocity was estimated at about 288,000 miles per ond, and until within a recent period, in spite of all analogy

and even of experience, Wheatstone's determination was supposed to hold good, at least approximately, for galvanic currents as well as for electricity of high tension, and for bad as well as good conductors. The telegraph operations of the Coast Survey demonstrated at the very outset the inaccuracy of received ideas upon this subject: they shewed that the galvanic current moves very much less rapidly than electricity of tension, varying according to Dr. Gould's discussion of the observations, from 12,000 to 18,000 miles per second, and though not yet fully reduced, they have rendered it, to say the least, probable that the velocity also diminishes as the resistance to conduction increases. Special investigations directed to all these points have been undertaken, and a volume of records and results is now preparing.

To determine the difference of longitude between Cambridge, Mass., and Liverpool, four distinct chronometric expeditions have been sent out, namely: in 1849, 1850, 1851, and 1855. In the last expedition the number of voyages made was six, and the number of chronometers sent out fifty-two. The first three chronometric expeditions gave results which could not be considered as satisfactory, in consequence of the remarkable influence exerted upon the chronometers by differences of temperature, though the instruments were compensated in the usual manner. In the expedition of 1855 an uncompensated chronometer was employed with the others. Great care was taken to observe the temperatures of the chronometers themselves during the voyage by means of thermometers, and the results of the compensated instruments were carefully compared with those of the single one without compensation. The chronometers employed were moreover carefully investigated before the expedition, by exposing them to different degrees of heat and noting the effect upon the rate. The observations of this last expedition, after careful discussion, have given a difference of longitude between Cambridge and Greenwich of $4^h\ 44^m\ 31^s{\cdot}89$, with a probable error of about 0·2 of a second. The successful laying of the telegraph wire between Europe and America is anxiously looked forward to as presenting an opportunity for determinations of longitude by the most perfect method which human ingenuity has yet devised. The importance of this single determination can scarcely be over-estimated, since it fixes the geographical relations of the old and new worlds.

In connection with its astronomical and geodetical observations, the Coast Survey has been enabled at a trifling expense to carry out an extensive series of determinations of the three magnetic elements at very numerous stations. These elements it will be remembered are the declination, inclination, and horizontal intensity. So great has been the amount of material ac-

lated, that the report for 1856, now in process of publica- contains for the first time, magnetic charts of the North ican continent sufficiently complete to enable us to compare the large scale for our own country, the results of observa- nd of theory. In these charts the lines of equal variation, id intensity are traced, and a comparison of the two former hose deduced from the general theory of Gauss exhibits a ctory agreement in form. Further observations, especially interior, are wanting to enable us to make this comparison itatively, as well as qualitatively. The determinations of clination and variation at points actually upon the coast, great service in navigation. The report of 1856 contains ery valuable and elaborate discussions of the secular varia- of magnetic declination and inclination, both upon the n and western coasts, reference being had to the earliest led observations. Empirical formulas are also given for a er of stations, which enable us to determine with a satis- y approximation, the two angular magnetic elements at equired epoch.

the progress of the hydrography of the Coast Survey, very rous observations of the tides have been made for the pur- of correcting soundings, and of determining the establish- of the different ports. The necessity of both these classes ervations is sufficiently obvious, but the superintendent has cted with them observations of a more permanent charac- order to ascertain the laws of the tides in particular local- and to trace the progress of the tide wave along the coast lly, as well as in bays and rivers. For these observations pecies of gauge have been used; the self-registering and ommon staff gauge. The former possesses the advantage uiring little or no attention, and of furnishing a permanent eliable record in the form of a curve of which the abcissas ent the times and the ordinates the corresponding heights ter. The number of principal stations for tidal observa- was 73, of which number 45 were on the Atlantic Coast, the Gulf, and 10 on the Pacific.

ce the commencement of the survey there have been in all dal stations, of which however a comparatively small num- ive been furnished with self-registering gauges. The results ied have been of great practical importance, giving as they r the first time accurate information with respect to the of the Gulf and of the Pacific coasts, and leading to the ruction of accurate and reliable tide tables.

s not saying too much to assert that no single series of observations yet made possesses so high a scientific value as of the Coast Survey. Not only is the range of coast d greater, but the character of the tides themselves is in a

great measure sufficiently free from the effects of local causes to enable us to obtain from them results of definite value for the general theory. On the other hand the Gulf of Mexico and particular portions of the Atlantic Coast exhibit peculiarities of much interest, as yet imperfectly investigated, but seeming to show the importance of a careful study. While the tidal observations hitherto discussed have been for the most part isolated, made at different points upon the earth's surface by individuals, during a period of about 200 years, those of the Coast Survey have been made systematically, at numerous carefully selected stations, upon the coasts of a continent lying between two great oceans, and under the direction of a single person.

An elaborate discussion of these observations has led to the construction of maps of the cotidal lines of the Atlantic, Gulf and Pacific coasts, which are of especial interest not merely from their connection with our own shores, but from the fact that they are the only series of cotidal lines yet deduced from an extensive and connected series of observations. The term "cotidal line" it will be remembered was first introduced by Mr. Whewell to denote a line passing through all those points which have high water at the same hour of the day. It is convenient to assume twenty-four such lines, and they may obviously be regarded as forming the crests of successive advancing tide waves. Their shape, velocity, and direction of motion, will depend upon the configuration of the coast, the depth of the ocean and the various local causes which disturb the uniformity of their progress and cause divisions and interferences of divided waves. Were no disturbing causes present, the cotidal lines would correspond with the meridians, each line at a certain distance behind the meridian of the moon at its culmination. It is easy to see too that the cotidal lines must differ upon the eastern and western shores of a continent like that of North America, since the tide wave moves from east to west and is therefore upon the eastern coast an incident and upon the western a receding wave, the character of which is determined by the flow of water and its pressure from north, south and west. The cotidal lines of the Atlantic coast follow the general outline of the coast itself in a remarkable manner, the velocities measured in a direction perpendicular to the front of the waves varying from 24 to 40 miles per half hour. The tides on the Atlantic coast are of the regular semi-diurnal class; the diurnal inequality is not large and generally difficult to trace, though easily recognized at particular periods. On the Gulf coast, on the contrary, the tides are small, the semi-diurnal being masked by the diurnal waves. The tides of the Pacific coast are remarkably regular, both in the diurnal and semi-diurnal waves, and moreover rise to such heights as to render observation easy. Throughout the extent of coast exam-

ined, the cotidal lines for the Pacific are either sensibly parallel to or make but a small angle with the coast.

Tide tables for the principal sea ports of the United States have been published by the Superintendent of the Coast Survey by authority of the treasury department; they are based exclusively upon the observations of the survey, and will be extended and corrected as the survey advances. Meantime their value to navigators places them among the important results of the Coast Survey.

The tidal observations of the Pacific coast have casually led to a determination of great scientific interest, that of the average depth of the Pacific Ocean between the coasts of Japan and California. On the 23d of December 1854, an earthquake occurred in Japan by which the town of Simoda in the island of Niphon was destroyed. From the imperfect accounts which have reached us it appears that at 9 A. M. on that day the severe shock of an earthquake was felt on board the Russian frigate Diana, then lying in the harbor of Simoda. Half an hour later the sea came into the bay in an immense wave thirty feet in height, overwhelming the town and then receding. This advance and recession occurred five times, and by 2·30 P. M. all was again quiet. The depth of the sea during these changes varied from less than eight to more than forty feet. Upon the same day an extraordinary rise and fall of water was observed at Peel's Island, one of the Bonin Islands, and the tide continued to rise and fall during the day at intervals of 15 minutes, gradually lessening until evening.

The self-registering gauges at San Diego and San Francisco, exhibited on the 23d and 25th of December, remarkable irregularities of the tidal curves. Each gauge exhibits three sets of waves at short intervals, and there can be no doubt that these waves were produced by the same cause which determined the rise and fall of the ocean at Japan and the Bonin Islands. No record of the occurrence of an earthquake in Japan on the 25th of December has yet reached us, but the waters rose on the evening of that day at Peel's Island to the height of 12 feet. The distance of Simoda from San Francisco is 4,527 nautical miles, and from the same port to San Diego 4,917 miles. From these data and the times at which the disturbances occurred upon the two coasts, the waves from Simoda to California would move at about the rate of 360 miles per hour or 6 miles per minute, and would have a length of about 200 miles. This would give for the average depth of the Pacific about 2,200 fathoms or rather more than two miles. The publication of the official report of Admiral Pontiatine who commanded the Diana will probably permit more accurate determinations and explain the origin of the disturbance upon the 25th of December.

(*To be concluded.*)

ART. XII.—*The Open North Polar Sea;* by R. W. HASKINS, A.M.

THE physical condition of our globe, though intimately connected with the daily walk and welfare of man, is a subject which never has occupied more than a very slight share of the popular attention. There are features, however, of this condition, which occasionally force themselves upon the attention of all men; though seldom for more than a brief period, and then only as an element of alarm or of idle curiosity, rather than as one of investigation, and as forming the basis of knowledge. Such are earthquakes, sudden eruptions of volcanoes, and the like. The more fixed and stable forms of surrounding nature, as they lack the stimulant of unusual and violent change, can excite, in the public mind, none other than the most feeble attention, and that only under circumstances of specific incentives. Among the direct consequences of this state of things is a constant propensity to generalize, and to base ultimate conclusions upon appearances only, and with none other than a superficial observation of these. It is to such a propensity, and to the apathy it so naturally produces, that we may, perhaps, most safely ascribe the present condition of the popular mind, in regard to the immediate object of this notice.

That to recede from the equator towards the poles, upon the surface of the earth, is to encounter increased cold, is a *general* fact, well known to all; and it was easy for even the most drowsy quietude to *infer*, from this, that the law thus known is a constant one admitting of no exception, and that, consequently, the geographical pole must be the coldest point of our globe. How far the votaries of science may have concurred in this sentiment, and even contributed to its establishment, it is, of course, quite impossible to determine. It is however a fact, that all the later meteorological charts place the regions of greatest cold on the continents, and *not* within the polar sea.

This being the state of the public mind—a state wholly undisturbed by any efficient teachings—the announcement, by the late Dr. Kane, on his return from his northern explorings, in 1855, that there existed, and that some of his people had seen, an open sea or ocean in north latitude 82° 30′, was very generally received with astonishment; and it very widely produced that species of undefined amazement, which might well belong to assumed phenomena in nature, that had hitherto been deemed physically impossible. However little creditable the fact just stated may be deemed to the mass of those whose standard of intelligence, upon the physical condition of our globe near the North Pole, is measured and fixed by it, yet most certainly those who had made the physical condition of

the earth's surface a reasonably successful study, had ample cause for real astonishment at the great extent to which all the teachings of the past, in regard to this open northern polar sea, had been either overlooked or forgotten.

Since the occasion in question has fixed so much attention upon this open sea as a new thing to us all, and is still employing so many pens upon it as such, it seems a fitting time to place the more general public in possession of the past knowledge of this sea, in a collected form, by way of giving profitable direction to the laudable public zeal which is just now so earnestly manifested in the case.

This unfrozen polar sea, then, has been long known and often navigated, at different periods, and by different nations and vessels. The earliest no less than the most persevering navigators of high northern latitudes, were the Hollanders or Dutch and the Greenlanders. These people did not resort to these latitudes year after year for the purpose of scientific discoveries of any kind. Their purpose was whale and seal catching, and to whatever regions they penetrated, they were led solely by the pursuit of these creatures. Now it is from these early navigators thus employed, and chiefly from the log-books of their ships, that we have derived almost all we know of a constantly open sea about the north pole of the earth. Nor is the peculiarly reliable nature of this testimony to be overlooked. It comes, as we have said, from men who had no theory to sustain or combat, and no end to serve or aim to accomplish, by falsifying or perverting the record. Again, this record of the log is not one of an afterthought that may be made to conform to events that have transpired after its date, but it is one that is written out daily and at the period of its date—thus constituting a daily and even hourly record of events as they transpire on board. Of the great mass of this species of evidence that has doubtless been brought home by the ships from the polar regions, we may well suppose we possess but a very small proportion, since all we have owes its preservation either to accident or the individual efforts of devoted men. In proceeding to cite the evidences we possess in this matter, we may premise that a large portion of them were collected from their various sources by the Hon. D. Barrington, and by him published at London in 1776. As the citations we are about to make are numerous, and also cover a very considerable range of time, we have thought to add to their more clear understanding by arranging them in their natural or chronological order, so far as it has been possible to ascertain this.

Davis, an English navigator, who was sent north with two ships in 1585, to discover a northwest passage, and who did discover the straits that bear his name, is, by modern authors,

credited with having reached only 66° 40′ north latitude, while Camden, in his annals of Elizabeth, asserts that Davis attained to 83°.

Moxon's account of a Dutch ship that sailed to the pole, and even beyond, is this: Being, says he, about 22 years ago, in Amsterdam, I went into a drinking house to drink a cup of beer for my thirst, and sitting by a public fire among several people, there happened a seaman to come in, who seeing a friend of his there who he knew went in the Greenland voyage, wondered to see him, for it was not yet time for the Greenland fleet to come home, and asked what accident had brought him home so soon? His friend (who was the steerman [mate] aforesaid in a Greenland ship that summer) told him that their ship went not out to fish that summer, but only to take in the lading of the whole fleet, to bring it to an early market. But, said he, before the fleet had caught fish enough to lade us, we, by order of the Greenland company, sailed unto the north pole, and came back again. Whereupon (his relation being novel to me) I entered into discourse with him, and seemed to question the truth of what he said, but he did insure me that it was true, and that the ship was then in Amsterdam, and many of the seamen belonging to her, to justify the truth of it; and told me, moreover, that they had sailed two degrees beyond the pole. I asked him if they found no land nor islands about the pole? He told me no, there was a free and open sea. I asked him if they did not meet with a great deal of ice? He told me no, they saw no ice. I asked him what weather they had there? and he told me fine, warm weather.

This conversation, &c. at Amsterdam was about the year 1624, at which time the vessel had lately returned. Moxon, who related this statement, was not an obscure nor an illiterate individual, since in the title to his published statement he calls himself Fellow of the Royal Society, and Barrington states that he was Hydrographer to Charles the Second, and author of several scientific papers. It was probably his professional calling, therefore, that fixed his attention upon this subject, and thus caused his inquiries at Amsterdam. A map was early published by the Academy of Sciences at Berlin, which places a ship at the pole, as having arrived there, according to the Dutch accounts. We are not aware that the date of this map is preserved, but it seems probable that one of the authorities for that ship's position is the account of Moxon, cited above.

Wood sailed on the discovery of a northeast passage to Japan, in 1676; and in his account of his voyage, which he subsequently sent to the press, he says he was chiefly induced to the undertaking by the account given by Capt. Goulden, of a Dutch ship, who had made some thirty voyages to Greenland. This

in's statement was, that being in company with two other
ıd ships to the eastward of Edge's Island, in pursuit of
s, and these not appearing there, the two Hollanders re-
l to go farther north. They did so, and at the end of two
returned again and said they had sailed to latitude 89°;
hen Capt. Goulden doubted this, they produced out of the
ıips four journals or log-books, which confirmed the state-
and did not differ from each other in all but four minutes
legree. In this run to the north they encountered no ice,
ıd a free and open sea. This occurrence is stated by Capt.
len to have taken place some twenty years before its narra-
ɔ Wood, which places it somewhere about the year 1650.

1662 Mr. Oldenburgh, Secretary of the Royal Society,
ɔn, was ordered to register a paper entitled "Inquiries con-
ıg Greenland, answered by Mr. Grey, who had visited
parts." To the question "How near hath any one been
n to approach the pole?" Mr. Grey answered,

once met [date not given, but of course prior to 1662]
the coast of Greenland, a Hollander that swore he had
but half a degree from the pole, showing me his log-book,
ı was also tested by his mate; where they had seen no ice
.d, but all water."

Campbell, who compiled Harris's Travels, states therein
"By the Dutch journals they get into north latitude 88°
ınd the sea open." On being asked his authority for this
ıent, Dr. Campbell answered that he received it from Hol-
as being an extract from the journals produced to the
ı General, in 1665.

rtin, in his voyages, says, "in 1671 we sailed to the eighty-
legree, and no ships ventured farther *that year*."

Dallie, a native of Holland, who resided in Racquet Court,
Street, as a practising physician, about the year 1745,
to Dr. Campbell, who is mentioned above, that when he
oung he sailed in a Dutch man-of-war that was sent north
›tect the whale fishery, and that the ship, on that occasion,
ed latitude 88° north, where the weather was warm and
ea wholly free from ice. The date of this voyage may
been about 1685.

ob Schol, who resided at the Helder, in 1700 sailed to 84°
in pursuit of whales, and had open sea there without ob-
ion.

drew Fisher, an English captain, who had made twenty-
'oyages to the Greenland seas, testifies that, in the year
in the ship Ann Elizabeth, from London, he sailed to 82°
ɔrth, where he met a loose pack of ice. He fished there,
'ent no higher north, but had no doubt he might have done
rough all the ice there was, had he been so minded.

In 1751 Capt. MacCallam, in the ship Campbeltown, in the Greenland whale fishery, sailed to latitude 83° 30′ north, where the sea was not only wholly open at the north, but where he had not seen a particle of ice *for the last three degrees*, and the weather warm and pleasant. In this case, to make certain of their position, careful observations were made, both with Davis' and with Hadley's quadrants, and by no less than three different persons. The captain feared to go farther, lest he should be blamed for neglecting his fishing, which was his only reason, as there was no obstruction.

In the year 1752, Mr. John Phillips was mate of the ship Loyal Club, in which ship he reached 81°; and he stated that it was very common to seek whales in such latitudes.

The year 1754 was more fruitful than any prior one in recorded visits to this open polar sea, since we have records of no less than three such visits during this single year. Capt. James Wilson, of the whale ship Sea Nymph, made his way through all the ice, the last of which was seen below 81°, sailed thence north to 82° 15′, where the sea was perfectly clear as far as could be seen with the ship's glasses. Here the ship's officers discussed the proceeding directly to the pole, but the sailors fearing to do so, the proposition was abandoned. In the same year the whaling ship Unicorn, Capt. Guy, reached 83° 3′, determined by careful observations; and here, from the mast head, they saw the sea as free of ice as the Atlantic, on every side, and nothing in the way of sailing directly to the pole. The third instance of this year is that of Mr. Stephens, who, in company with another, a Dutch ship, was driven off Spitzbergen by a south-southeast wind to latitude 84° 30′. This was within 5° 30′ of the pole; and he met with little ice, and the less the farther he went north.

In 1756 Capt. Montgomery, of the ship Providence, pursued whales to latitude 83°, in the month of June, with open sea upon the north.

In 1759 Capt. H. Ford, in the ship Dolphin, went as far north as 81° 30′, and he states that he has since that been several times as high as 81°.

James Bisbrown, in the ship Prince Frederick, in 1765, reached latitude 83° 40′ north, where he was beset with ice for three weeks, *to the southward*, but saw, during this time, open sea to the north.

The year 1766 has furnished us two instances of high northern navigation. Jonathan Wheatley, not finding whales sooner, sailed to 81° 30′ north, in which latitude he could see no ice whatsoever in any direction from the mast head, though there was a very heavy sea from the northeast. Capt. Thomas Robinson, in the ship Reading, was this same year in latitude 82° 30′, with an open sea.

1767 Samuel Standidge sailed from Hull, England, on the ship British Queen, of which he was owner but not r, for the north seas. On the sixth of May this ship ed latitude 80°, "which," says the narrator, "is near what asters call a fishing latitude;" and he adds, "I found the r north the less quantity of ice."

· the year 1770 we have two instances to cite. James Mar- as mate on the ship Royal Exchange of Newcastle, was 'ear in latitude 82° 30′ north. Capt. Brown, of the ship ove, states that he was in latitude 82°, this same year, and he sea was then all clear.

e year 1771 seems to have been a favorable one for high ern penetration by water. Capt. Jan Klass Castricum, in hip Jonge Jan, fished with success in latitude 81° 40′, in any with a ship from Hamburgh. There were, also, two sh ships fishing there; and these went still farther north, they were out of sight from the mast head. They were thus between two and three days, and when they returned captains came on board Castricum's ship, and assured him hey had been as far as 83°.

1773 Capt. John Clarke, of the Sea Horse, went to 81° 30′ he had an open sea to the north, and a heavy swell from ortheast, with a fresh wind. Capt. Bateson, of the ship e, on June 14th of this year, was in north latitude 82° 15′, suit of whales, and with no complaint of ice.

e *Journal des Sçavans* for the month of October, 1774, states n officer in the English service had then in his keeping the als of a Greenland ship wherein it stands recorded that ship, in the month of May—the year not given, but sup- to be then recent—had been in latitude 82° 20′ north, and he sea was open.

s mass of testimony, it is seen, has been chiefly gathered foreign languages, and been furnished by other than Eng- avigators. The reason of this is that the English were not arly navigators of these high latitudes. Those hardy ad- rers were Hollanders and Greenlanders, who, jointly, long polized the whale fishery in the Arctic seas. No general e or ambition, then, has existed in England to preserve romulge the details of the voyages made by these people; ence we know not what proportion of such material as the may be still unknown to us by having been lost. Certain at many instances of such are found, scattered here and which are not so fully authenticated as to seem deserving lace here, and they have therefore been excluded.

ce the concluding date of the foregoing list of proofs of an sea at the north pole, we have no evidence that ships have rated that sea as they formerly did. Modern explorers,

which, within the last forty years have been numerous, hav done so, having invariably been stopped by ice, and usual much lower latitudes than where this open sea has ever known to extend. But, although these modern explorers not reached that sea, and sailed their ships upon it as their decessors did, still some of them have brought us as demon tive proof of the existence of that open sea as if they had ally floated thereon. One of these is Capt. Parry, who win at Melville Island, in latitude 74° 45′ north. He tells us there a *north* wind, in the long winter of that frozen re modified the cold, and if continued, produced a thaw. this single fact, if well established—and we take this one to without one particle more of evidence, would establish be all doubt or controversy, the existence of an open sea, i direction whence that wind came. Such an effect from a is wholly incompatible with the assumption that it has p only over a *frozen* surface. This statement of Capt. Par fully confirmed by other proofs—or rather those other p being of prior date, are confirmed by it. Barentz, whe ship was frozen in Nova Zembla, heard the ice broken, w most frightful noise, by an impetuous sea, from the north; the Samoides and Tartars, who live beyond the Waygat, a lieve, and we must suppose from like reasons, that the s open, on the north of Nova Zembla, all the year. The mony of persons who have passed the winter at Kola, in land, coincides perfectly with this, namely, that, in the severe weather, whenever a northerly wind blows, the promptly diminishes, and that, if the wind continues, it al brings on a thaw, as long as it lasts.

If we ask why these more recent navigators could not the high latitudes their predecessors did, the only and the cient answer is, that the icy barriers which always exist *on th* to this open sea and south of it, vary greatly in solidity and in different years. These barriers have always been p through by those who have entered the open polar sea, and have often proved too broad and solid to be penetrated a The fact of these wide differences in the extent and streng the ice in the northern seas in different years, is attested l we know of the regions in question, whether by land o All the history of Greenland attests it, and the fact is n constantly proved by the experience of northern whalers. cite a single case in illustration, and that a recent one, we mention that of Capt. Parry. This navigator, during his voyage in 1824, found the icy barrier in Baffin's Bay *one hu and fifty miles* broader than when he passed it in 1819. differences, then, that exist in these icy barriers, in lati *south* of the open polar ocean, and in the most favorable se

ifferent years, sufficiently account for both the successes and failures of navigators in reaching that open sea; while the 'y ocean swell, and the warm winter wind, both of which oach this icy barrier upon the *north*, and that, too, during fiercest frosts of the northern sunless winters, appear to 'e that the ocean towards the north pole is, even then, still ı, and that it warms and tempers those winds which pass ' it, and which so constantly drive its waves against that 'ampart by which the frost king has fixed and defined its hern shore.

'. XIII.—*Correspondence of M. Jerome Nicklès, dated Paris, August*, 1857.

bituary.—Cauchy.—In my last communication I gave some raphical details respecting the great mathematician Cauchy. recent publication of a notice by Biot, one of his cotempo- ɜs and friends, leads me to return to the subject.

auchy was born on the 21st of August, 1789. At an early he was distinguished by great versatility of talents. His sical education, commenced by his father, was continued un- able professors at the "Ecole Centrale" of the Pantheon. left the school at the age of fifteen, after two years of literary ies, taking the second prize in Latin composition, the first Greek, and the first in Latin verse. On account of this so 'ersal success, the Institute decreed to him the highest honor rved for the student of the central schools most distinguished lassical literature.

fter two years at the Polytechnic School, he left it to become ngineer in the Department of Roads and Bridges. On the of May, 1811, at the age of twenty-two, he presented to the itute a memoir of remarkable character, on geometric poly- ons, in which he generalized a theorem of Euler and com- ɜd the theory of a new species of regular polyhedrons dis- ɜred by Poinsot. M. Legendre, the most severe of our geo- 'icians, regarded the memoir "as the production of an adept se ability promised the highest success." He engaged the ıg author to pursue this line of research, and to endeavor to blish a theorem equally applicable to certain polyhedrons raced in the definitions of Euclid for which no demonstra- had yet been made out. Cauchy accomplished this in 1812. ıis report thereon to the Academy, Legendre expressed his 'obation with an earnestness quite unusual for him.

hese two earliest memoirs seemed to show a special aptitude ɔroblems purely geometrical. But it was soon evident that ɜapacity was far wider. In the years 1813 and 1814, Cauchy

produced two remarkable memoirs in transcendental analysis; in 1815, he published his memoir on the theory of numbers, in the course of which he demonstrated in full a theorem announced by Fermat, a theorem which had hitherto been demonstrated only in some of its particulars by mathematicians most skilled in these departments, as Gauss and Legendre. The Academy proposed this year, as a subject for the great mathematical prize,—To establish the theory of the propagation of waves on the surface of a heavy fluid, and of indefinite depth. Cauchy resolved the question completely. His memoir was crowned in 1816, and bore this epigram from Virgil, "Nosse quot Ionii veniant ad littora fluctus," (Georgics II,) a very happy selection, as the line contains a complete and altogether exact announcement of the proposed problem.

Successes so rapid and fertile for a young man of 27 years, assured him the first place that should become vacant in the Mathematical Section of the Institute. A circumstance which is an occasion of regret to science and himself, introduced him officially into that body. On the return of the Bourbons, a royal ordinance of the 21st of March, 1816, reëstablished the Academies under their primitive designations, of Académie Française des Sciences, des Inscriptions et Belles-Lettres, des Beaux-Arts; and carried out the new organization. In the Academy of Science, two celebrated names, those of Carnot and Monge, were replaced by two new names, those of Breguet and Cauchy.

Towards the end of 1813, Cauchy was named Adjunct Professor of Analysis at the Polytechnic School. He became full Professor in 1816. He was eminently a man of duty. Called to instruct, he turned all his thoughts to instruction. From 1816 to 1826, he published his course of Algebraic analysis, Differential Calculus, and Application of Infinitesimal Analysis to the theory of Curves,—three excellent works, well arranged, proceeding with demonstrations that are both rigorous and rich in new details. In this period he also published a memoir on the Integrals taken between imaginary limits—a subject that has given rise to several important works among our young geometers.

In 1826, he undertook the publication and authorship of a periodical review, styled "Exercises Mathematiques," in which all departments of mathematics, elementary as well as transcendental, were treated with so much generality, fertility and inventive power, that Abel, one of the profoundest analysts of our times, after reading one of these publications, wrote to a friend, "Cauchy is the geometer who best understands how mathematics should be studied." In fact the inventions of new methods and devices scattered through these "Exercises," have been not only for the author, but also for many other geometers,

the fertile initiatives of numerous brilliant works. Cauchy continued the publication of this Review until his death.

The revolution of 1830 interrupted his quiet life. At this time he was married and the father of two daughters. Besides his professorship in the Polytechnic School, he had a chair in the Faculty of Sciences at Paris, and was supplying the course of mathematical physics in the College of France. The new government imposed an oath of allegiance on all its officers, even those engaged in teaching physics and mathematics. Cauchy quitted his place and went to Switzerland. The king of Sardinia, informed of his voluntary exile, created for him in the University of Turin, a special chair of mathematics, which he filled with distinction, still continuing his other labors. In 1832 he left this chair, having been called to Prague by the ex-king, Charles the Tenth, for the education of the Count de Chambord. His wife and daughters joined him there, and with him followed the Princes to Goritz; during six years at this place he prepared a large number of valuable memoirs, which are now spread over Germany. Towards the end of 1838, his duties as preceptor terminated, and he separated from his scholar and returned to France, where he took his place among the members of the Institute. From this time, without distractions from professional duties, and diverted only by labors of beneficence or of a moral nature, he gave full freedom to the activities of his mathematical genius. During the last nineteen years of his life, he published in the volumes of the Academy and the Comptes Rendus over 500 memoirs, besides numerous Reports on memoirs presented by others. In this mass of work, so rapidly produced, many portions have their great value wrought out complete, while others present the initiatives of ideas which have either already proved fertile in results, or will yet do so. They treat of the highest subjects in mathematics:—the perfecting and extension of pure analysis,—the direct determination of the planetary motions and their most complex inequalities,—the undulatory theory of light, considered in its entire generality. Unhappily, his precipitation in producing did not leave him time to bring his results to full maturity. Each new path opened to him excited the deepest passion, and into it he plunged, neglecting what he had been exploring, even without taking the time to recognize where his methods were conducting him. To work with greater rapidity, he employed a notation full of unusual abbreviations, which render his manuscript calculations unintelligible to any one but himself. The exuberance of his genius needed, to bring out its greatest results, to be engaged in some special line of duty; and a chance was soon offered him.

In 1840, the death of Poisson left vacant a place in the Bureau of Longitudes; and Cauchy was nominated unanimously by the

board. But it was evident to all that Cauchy would not and could not take the oath, and so his nomination was not ratified by the government. It was to the loss of science; for with astronomical labors thus made his duty, he would have carried into them his usual ardor, and the "Mécanique Céleste" would probably have been advanced by new discoveries, for which we shall now have long to wait.

It was his fidelity to a sense of duty, which was afterwards the occasion and cause of his rendering a great service to astronomy, in furnishing it with the means of estimating, directly, by analytical formulas universal and certain in their application, the secular inequalities of planetary movements, which inequalities render any tables of these movements more and more faulty. In 1843, Cauchy was charged by the Academy with verifying the determination of an inequality of this kind which M. Le-Verrier announced he had discovered in the motion of the planet Pallas, the period of which embraced 795 years. It was highly important to know it, for its maximum effect on the longitude of the planet exceeded fifteen minutes of a degree, according to the valuation of LeVerrier. A direct analytic process being impracticable he secured the desired result by a very bold numerical interpolation, which required immense calculations. To relieve himself from the labor of verifying such an array of numbers, Cauchy invented an analytic method by which errors of this sort are determined directly, in all cases and with a precision in proportion as they belong to a higher order. He thus reproduced the results of LeVerrier; and henceforth in problems of this nature, the power of abstract science will supersede individual labor.

After the revolution of 1848, the Republic, more tolerant than the preceding Monarchy had been, restored to Cauchy the mathematical chair in the Faculty of Sciences of Paris, the only one of the ancient professorships which had remained vacant from 1830. Justice to him requires that it should be told that he gave to the poor the emoluments of the place.

M. Biot concludes his sketch with the following remark: "The view which I have given of the external circumstances of the life of Cauchy, shows us not only what he was, but also what he might have been as a mathematician. Had he been able, like Euler and Lagrange to spend his life, without disturbance, in quiet study, he would have been one of the grandest lights of mathematical science. By reason of the irregularity and disorder which external events impressed on his genius, his influence on this science will not be fully appreciated until time shall have developed all their consequences."

Note.—The preceding is derived from the article by Biot. We add to it the following.

[n 1851, after the fall of the Republic, Cauchy was again der the necessity of suspending his duties at the Faculty of ience, since he would not take the oath of allegiance. Hapy, this suspension was of short duration. On the proposition the minister of Public Instruction, M. Fortoul, the oath in case was dispensed with, and consequently he resumed his ice and held it till his death. What is not stated by Biot, we iy say—that it was at Biot's demand that this act of justice is brought about. M. Fortoul, who was then candidate for the :ademy of Inscriptions and Belles Lettres, of which Biot was e of the most influential members, having called on Biot with ference to his appointment, the latter profited by the occasion inform the Minister how happy it would be for science, if ientific instruction were not sacrificed to political considerans, so far at least that the great men of science should not be quired to take an oath against their consciences; and among ese last, Biot mentioned Cauchy. Three days afterward, uchy was excused from the oath, and thus justice was done.

Anesthesis.—Amylene—The use of amylene in anesthesis has et with a serious chéck in the death from the use of it of young man of 24 years, while in robust health. Dr. Snow put m to sleep in order to remove an epithelial tumor from his ick. The surgical operation was just begun, when the patient as seized with a fit of laughing which continued nearly a mine. When quieted, a little more amylene was administered. At e close of the operation, his respiration became embarrassed, s pulse feeble, and on trying to wake him, it proved to be too te; the asphyxia was complete. It was naturally inferred at the patient had breathed too much amylene. According to r. Snow, the air which a patient respires ought not to contain ore than 15 p. c. of amylene, just as it should not contain over p. c. of chloroform; and he holds that with a measured quan:y there would have been no accident. The recently invented paratus of Dr. Heurteloup meets precisely this case, and offers new method of operation.

Anesthesis by "Projection."—To avoid the accidents due to exssive inhalation of the anesthetic agent, and especially to insure iat the material should be mixed with the requisite amount of r, Dr. Heurteloup, known in surgery for the invention of Lith:ripsy, has contrived an apparatus for this end, (having in his xperiments made use of chloroform). The apparatus is like a ringe with a small bellows for throwing in air in place of the iston, and having a gauze partition on which the chloroform is oured. The working of the bellows throws a stream out of the nall end in a jet, which contains more or less chloroform, acording as the discharging tube is brought more or less near to ie bellows. The jet is established only on working the bellows, ad there is no waste of chloroform during the operation.

Compressed air.—It is well known that in the construction of the Franco-Italian railroad it is necessary to tunnel Mount Cenis through a distance of several kilometers in length. To supply the air needed for the workmen for respiration, it has been proposed to use powerful pressure. But no means of accomplishing this result have been devised, and the project of the tunnel is suspended. It is found that an increase in the length of a tube connected with a blowing machine diminishes, at a rapid rate, the intensity of the movement. This calls to mind the experiment of Wilkinson, who established the fact of the resistance exerted by the walls of a pipe on the velocity of the compressed air. M. Daru, engineer on the Northern railroad, has added the following facts meriting consideration. A wheel which made thirty revolutions a minute in driving a blast through straight pipes one meter long, made only twelve when the pipes were four meters long and were bent twice at an angle, one of them right and the other very obtuse. When, on taking the air from close at hand the effect produced was great, it was very feeble when it came through pipes ten meters long with a right angled bend.

In the experiments by Wilkinson, the compressed air ceased to be transmitted at 280 meters; and it is not 280 meters, but a length of several kilometers, which must be met at the tunnel of Mount Cenis. The question therefore is far from being resolved.

Artificial meadows; Cultivation of Madder.—In speaking in a former communication of the products of Algeria, we alluded to the value of the Madder (Rubia tinctorum) cultivated in that country. It has been found there that a plantation of madder may be used as pasturage for cattle for several years, without the roots, at the end of this time, losing any of their tinctorial qualities.

In March, 1851, M. Peyre, a farmer of Oran, sowed a quantity of madder in a field well prepared, the soil of which was strong and argillaceous. It was left without care and after the first year, through the years 1852, 1853, 1854, it was free to cattle, who found there abundant pasturage during the season of great heat. At the end of this time, the roots were pulled up and submitted to the examination of competent men; and they proved to be of excellent quality, even rivaling the best of French madder.

From these observations it results, that we may make, without great expense, artificial meadows on land deprived of any means of irrigation, and derive a crop of madder having all its coloring principle preserved.

Toxicology.—Researches on Arsenic.—Dr. Blondlot of Nancy has just observed a fact which explains the contradictions encountered by inexperienced chemists in attempts to detect arsenic in connection with organic matters. It is this:—that when sub-

ıces poisoned have been left to putrefy, some sulphuret of :nic is formed at the expense of the sulphuretted hydrogen, . this, as is well known, escapes detection by Marsh's appara-

Sulphuret of arsenic also forms when the suspected matters carbonized by the action of sulphuric acid after the process of ndin and Danger. The sulphuret of arsenic may be extracted washing the carbonized mass with ammonia; this dissolves sulphuret; then convert the arsenic into arsenic acid (AsO^5) means of boiling nitric acid, so as to obtain a second solution; ı, added to the first, may then be tested in Marsh's apparatus.

1quarium.—The aquarium has already become a common rce of amusement and instruction. The cultivation of water nts, as the Victoria regia, and experiments in pisciculture 'e contributed to this result; and also, the researches of Mr. ırrington, on what is called the organic equilibrium for waters, that the water in a globe, by a proper selection of kinds of mals and plants, may be kept pure and wholesome for the cies without changing it.

Che first idea of such aquatic reservoirs is attributed in the smos to Mrs. Power, a lady of French descent but English by rriage, known to naturalists for her important researches on llusca.

ın 1832, Mrs. Power took up her residence on the coast of ily in order to study the molluscs and other marine animals. ɜ remained there ten years and made two aquaria, one for lluscs without shells and the other for those with shells. The tom of the aquaria was covered with sand, stones with sea-eds attached, branches of corals, star fish, different crustaceans l some small fishes, while her principal object of study was *Argonauta Argo.* Situated on the coast she could readily ınge the water of the aquaria; the plan since developed by . Warrington was not then understood.

Mrs. Power also used marine cages, called in Italy "Gabiole ı Power," in England "Power cages," which she had con-ıcted in the lazaretto of Messina. Stones with Algæ, and als with adhering shells were introduced, and then, the Ar-ıauta, Echini, fishes, etc. The feeding of the animals was ɜnded to twice a day. A staging was erected just above the ter's surface, where the cage could be raised near the sur-ɜ, and the animals conveniently examined; and there Mrs. wer sat during the long hours carrying on her observations, nessing the Polypus or Cephalopod of the Argonaut mending shell, and studying the habits of many other species.

Mrs. Power also constructed a portable aquarium for study-small molluscs. Her researches were continued through fif-ı years, and many important results were contributed by her the progress of science.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *Electrolytic investigations.*—Under this title Magnus has published an elaborate and important memoir reviewing the results of previous investigations and containing many new and important facts. We shall here give only the author's summary, referring for the details to the original memoir.

(1.) To explain the so-called double decomposition observed by Daniell and Miller, it is not necessary to assume an oxysulphion, oxynitrion, &c. This assumption is refuted by the fact that compounds like S+4O, N+6O are never separated at the positive electrode. It is true that at this electrode a full equivalent of oxygen, corresponding to the metal separated, is found, but of the acid there is only a portion, frequently only 60 per cent. By employing a porous diaphragm the remainder of the acid is found in the negative cell.

(2.) When several salts are present in the same solution, the current at a certain intensity decomposes only one of them. In like manner when a salt dissolved in water is used as an electrolyte, with a certain force of the current only the salt, and not the water, is decomposed. There is therefore for every compound electrolyte a limit of intensity, at which only one of its constituents is decomposed.

(3.) When currents are employed the intensity of which is less than the limit, the whole quantity of electricity passes over to the substance to which this intensity relates. This substance alone is decomposed. The limit itself therefore corresponds to the maximum of electricity which can pass to this substance, or to the maximum of the substance which can be decomposed in a given time with unchanged electrolytes and unchanged electrodes.

(4.) This limit depends upon the size of the electrodes; on the decomposability of the different constituents of the electrolyte; and on the relative quantity in which they exist in it.

(5.) Since, in the application of the same intensity, the electrodes may be nearer to or farther from each other, the maximum of the better conducting substance which is decomposed by the same current and the same electrodes is the same, whether the electrodes are nearer to or farther from each other.

(6.) The limit of the intensity is proportional to the magnitude of the electrodes, provided that this section of the electrolyte is the same as the size of the electrodes. This proportionality holds good however only so long as the constitution of the electrolytes remains unchanged.

(7.) The conduction of electricity through an electrolyte, and the decomposition which takes place thereby, may be referred to the case of the induction of electricity upon insulated conductors.

(8.) In this manner the difficulty of the so-called double decomposition raised by Daniell may be overcome.

(9.) It requires the same force to separate a simple substance from a binary combination which is necessary to separate it from a more complex saline compound.

(10.) The same force is requisite to separate the same quantity of chlorine from the protochlorids as from the perchlorids of tin and copper. But we obtain in this way from the protochlorids twice as much metal with the same current as from the perchlorids.

(11.) The same force is also necessary to obtain equal quantities of oxygen from a solution of iodic acid and from dilute sulphuric acid which are decomposed in separate vessels. In this case however only one-fifth of an equivalent of iodine is obtained for one equivalent of hydrogen separated from the sulphuric acid.

(12.) Faraday's law is applicable in its fullest extent inasmuch as equivalent quantities are always separated from complex saline compounds. But the galvanic are not the same as the chemical equivalents.

(13.) Saline particles change their position in eletrolytes partly by continual decompositions and recombinations, partly by diffusion. The density of the solution exerts a sensible influence upon the diffusion, which is however different in different saline solutions.—*Ann. der Physik und Chemie*, cii, 52.

2. *On the influence which metals exert upon radiant heat.*—Knoblauch has communicated a memoir upon this subject the most important results of which in the author's own words are as follows.

(1.) Metals like gold, silver, and platinum in thin plates are to be regarded as diathermanous bodies, which allow a portion of the rays of heat to pass through, which portion diminishes more and more with increasing thickness of the metal.

In this transmission certain metals, for example gold and silver, exert an elective absorption upon the rays of heat analogous to that of transparent colored bodies upon rays of light; while others, like platinum, partly absörb and partly transmit all kinds of rays of heat in an equal degree, as is the case with transparent colorless bodies with respect to light.

Rays of heat, according to the foregoing statement, exhibit, after their passage through the metals of the first class, different relations, with respect for instance to their passage through diathermanous bodies, from those which they show before their entrance into these, and this peculiarity is expressed more distinctly in proportion as the metallic layer passed through is thicker. In metals like platinum this thickness exerts no influence on the quality of transmitted heat.

These last would behave like gray substances with respect to the rays of heat as well as toward the visible rays. Substances which can be compared with those which are transparent and white with respect to lights, appear not to exist for radiant heat.

(2.) In the case also of diffuse reflection, certain metals, as for instance gold, silver, mercury, copper and brass, like opaque colored bodies with respect to light, exhibit an electric absorption with regard to radiant heat, in consequence of which this becomes changed in its properties. Others on the contrary, platinum, iron, tin, zinc, lead, alloys of lead and tin, and german silver, reflect all kinds of rays of heat in equal proportion, exactly as colorless opaque bodies reflect lights.

The last gray metals behave similarly with respect to heating and visible rays. No bodies are known which act upon radiant heat as opaque

white bodies act upon light. The peculiarities which distinguish rays of heat reflected from metals from those which are not reflected, with respect for instance to their capacity to pass through diathermanous bodies, depend upon the nature of the source of heat to such a degree that differences which are strikingly marked in the case of the sun's heat, are diminished in the rays of a Locatelli lamp, and disappear completely with the heat of a dark heated metallic cylinder.

The quality of the metallic surface according as it determines a diffuse or a regular reflection has such an influence as either to permit the differences mentioned to be exhibited to their full extent, or again to disappear to such a degree that the rays are not to be distinguished from each other before and after reflection.

The same is true of a change in the angle of incidence. As this gradually permits the diffuse reflection of a rough metallic plate to pass into regular reflection, under a constantly increasing intensity, as the rays become more and more obliquely incident, so it also diminishes the differences between the reflected and non-reflected heat, till both at last exhibit a perfectly similar quality.—*Ann. der Physik und Chemie*, ci, 212.

3. *On an optical test for Didymium*—GLADSTONE has discovered in the spectrum produced by solutions of didymium two well marked black lines; one in the yellow directly following the bright space immediately beyond the fixed line *D*, the other in the green midway between *E* and *b*. The extreme blackness of the first of these lines even in thin strata of liquid renders its existence a very delicate and valuable indication of the presence of didymium. The salts of lanthanum and cerium produce no similar effects. One part of sulphate of didymium dissolved in 1000 parts of water showed the line in the yellow as a distinct darkening, when half an inch of the solution was looked through. The presence of other bodies does not interfere with the application of the test, so far at least as other metallic solutions have been studied.—*Quarterly Journal of the Chemical Society*, No. xxxix, 219.

4. *On the employment of the salts of alumina in the analysis of plants.*—ROCHLEDER has pointed out the superiority of alumina over hydrate of oxyd of lead for the separation of the proximate constituents of plants. The author in the first place remarks that organic substances may be divided into two classes with reference to their behavior toward alumina. Many coloring matters, as well as other substances, are precipitated by alumina from their solutions, while others on the contrary are not affected. Alumina therefore gives us a method of separating the one class from the other. The precipitates are less gelatinous than alumina and more easily washed out. In many cases a solution of alum may be added directly to the extract of the plant and the alumina then precipitated in combination with the organic matter by means of ammonia. As an example of the method, an aqueous decoction of horse-chestnut bark, treated with a solution of alum and then with ammonia, gives a fawn-colored precipitate. The filtered solution is wine-yellow. The solution neutralized with acetic acid and evaporated to dryness in a water-bath gives a mass containing the sulphates of potash and ammonium, a little acetate of ammonia and all the æsculin. This may be separated by boiling with a little strong alcohol and filtering. The æsculin crystallizes on evaporation and after a

single recrystallization is perfectly pure. The tannic acid is easily separated from the fawn-colored precipitate by solution in water containing acetic acid, filtration, precipitation with a salt of lead, and decomposition of the lead salt with sulphydric acid. In conclusion the author suggests that the employment of the hydrate of alumina will permit us to prepare many substances at a cheap rate which have hitherto found no application in consequence of their high price.—*Sitzungs berichte der k. k. Acad. zu Wien*, xxii, *quoted in Journal für prakt. Chemie*, 71, p. 414.

5. *On some derivatives of gallic acid.*—NACHBAUR has instituted at the suggestion of Prof. Hlasiwetz and under his direction, a series of experiments to determine whether ternary radicals can be introduced into the molecule of gallic acid. The process employed consisted in heating gallic acid with the chlorids of the radicals, acetyl, butyryl, &c. The author describes four substituted acids, the names and formulas of which are as follows:—

Tetracetyl-gallic acid,	$C_{14}\left\{\begin{matrix}(C_4H_3O_2)_4\\ H_2\end{matrix}\right\}O_{10}$,
Triacetyl-gallic acid,	$C_{14}\left\{\begin{matrix}(C_4H_3O_2)_3\\ H_3\end{matrix}\right\}O_{10}$,
Dibutyryl-gallic acid,	$C_{14}\left\{\begin{matrix}(C_8H_7O_2)_2\\ H_4\end{matrix}\right\}O_{10}$,
Dibenzoyl-gallic acid,	$C_{14}\left\{\begin{matrix}(C_{14}H_5O_2)_2\\ H_2\end{matrix}\right\}O_{10}$.

—*Chemisches Central Blatt*, No. 47, p. 740.

6. *On the combinations of tartaric acid with saccharine matters.*—In pursuing his investigations into the compounds formed by saccharine matters, Berthelot has been led to produce acid compounds of a peculiar nature with mannite, dulcine, and glucose. These compounds establish the constitution of a great number of natural compounds analogous to tannin, and capable, by taking up water, of splitting into glucose and a corresponding acid. In the present communication the author points out the combinations of tartaric acid with glucose, milk sugar, cane sugar, sorbine, pinite, quercite, and erythroglucine, as well as a compound of glucose and citric acid. All these bodies may be prepared and purified by the following process. Equal weights of tartaric acid and saccharine matter are mixed intimately and heated for a day or two in an open vessel to a temperature of 120° C. The cooled mass is rubbed with a little water and carbonate of lime and filtered. The filtrate contains the lime salt of the new acid, mixed with the excess of saccharine matter; it is precipitated by twice its volume of common alcohol, and the precipitate washed with alcohol and diluted with an equal volume of water. The lime salt is again dissolved in water and again precipitated as before, and these operations several times repeated. From the purified salt the acid may be separated by oxalic acid. The author represents the reactions which result in the formation of the new acids by the simplest possible formulas representing the ratio of the bodies concerned. These formulas show that, as in the case of alcohol in the sulphovinates, the saccharine body minus a certain quantity of water, replaces in the acid a portion of the base necessary to saturate this acid in the isolated state. It is probable that, as in the case of the compounds of glycerine, the

same sugar may form many compounds with tartaric acid. The author describes only those which he has obtained. For the formulas we must refer to the original paper.—*Comptes Rendus*, xlv, 268.

[*Note.*—From the above it will be seen that we owe to Berthelot the discovery of the true constitution of three entire series of organic bodies, viz., the glycerids or fatty bodies; the sugars and their congeners; and the glucosids or acid and neutral bodies which split into sugar and other acid or neutral bodies by boiling with acids, alkalies or water.]

7. *On the action of light upon oxalate of peroxyd of iron.*—DRAPER has communicated a paper on the measurement of the chemical action of light which, together with many interesting remarks and suggestions, contains a notice of the action of light upon the oxalate of peroxyd of iron. The golden yellow solution of this salt undergoes no change when kept in total darkness, but on exposure to a lamp or to daylight is decomposed with evolution of carbonic acid and precipitation of oxalate of the protoxyd as a lemon-yellow powder. In sunlight it effervesces violently. The indigo ray is especially active in producing this effect and undergoes absorption in doing so, since a sunbeam which has passed through one layer of solution is incapable of affecting another. The author points out several methods of employing this salt in photometry, the most advantageous of which is to collect and measure the quantity of carbonic acid absorbed in a given time. The solution is sufficiently sensitive for all ordinary purposes. When great sensitiveness is required the author recommends the use of the tithonometer invented by him in 1843 and since employed in a modified form by Bunsen and Roscoe.—*L. and E. Phil. Mag.*, Sept. 1847, No. 92, p. 161. W. G.

8. *On the Chemistry of the Primeval Earth;* by T. STERRY HUNT. (Extract of a letter to Prof. J. D. Dana, dated Montreal, Nov. 25, 1857.) —The primitive rocks which filled so large a place in the geological systems of the last century are now being forgotten. We have learned that the oldest visible portions of the earth's crust are made up of sediments, the ruins of still older rocks, which were as varied in their characters as are their derivatives. The primeval substratum has thus constantly receded before advancing science, and we are led to the conclusion that mechanical and chemical conditions similar to those of the present epoch presided over the formation of the most ancient rocks known.

But although the *materia prima* of the sedimentary rocks has long since been buried beneath its own ruins, its nature offers an interesting subject of consideration to the chemical geologist. If we admit the igneous theory of the earth, we may obtain a conception of the nature of the once liquid globe and of its atmosphere, by supposing the now existing matters of the earth's crust and the surrounding fluids to be made to react upon one another under the influence of an intense heat. The quartz would decompose the carbonate of lime with the production of a silicate and the liberation of carbonic acid, whose volume would be farther augmented by the combustion of all the mineral carbon at the expense of the atmospheric oxygen. The reaction between quartz and the chlorids of the sea, in the presence of aqueous vapor, would result in the formation of silicates and hydrochloric acid, while the sulphur would likewise be liberated as a volatile acid.

From these reactions there would result on the one hand a more or less homogeneous mass of silicates of alumina and alkalies, with silicates of lime, magnesia and iron, a mixture probably resembling dolerite, while the atmosphere would be made up of watery vapor, nitrogen, a probable excess of oxygen, with carbonic, sulphuric and hydrochloric acids representing all the carbon, sulphur and chlorine of the globe.

When the cooling of the globe had so far advanced as to allow of the precipitation of water from this dense atmosphere it would descend as an acid rain, which attacking, at an elevated temperature, the silicates, would give rise to chlorids of calcium, magnesium and sodium, mingled with sulphates of these bases. The liberated silica would probably separate during the cooling of the heated waters in the form of quartz.

The subsequent decomposition of the exposed portion of the primeval crust would result in the conversion of its feldspar into kaolin, and a soluble alkaline silicate, which decomposed by excess of carbonic acid would be carried to the sea as a bicarbonate, where decomposing the lime salt, it would give rise to chlorid of sodium and bicarbonate of lime, which would be partly precipitated in a crystalline form and partly secreted by marine animals. The carbonates of lime and magnesia set free during the slow decomposition of the primitive rock would also go to augment the proportion of carbonates in the ocean, and help to fix in mineral masses the carbonic acid of the atmosphere.

At length we reach the Carboniferous period of the earth's history, when a luxuriant vegetation completed the work of purifying the atmosphere, by transforming, as Brongniart long since suggested, the remaining excess of carbonic acid into carbon and oxygen gas, thus preparing the air for the support of warm-blooded animals.

By this hypothesis I think we get a clear conception of the generation from a primeval homogeneous mass of the quartzose, argillaceous and calcareous materials which make up the great bulk of the stratified rocks, and we obtain at the same time a notion of the origin of the saline constituents of the sea. The chemistry of the ocean, the formation from its waters of gypsum, rock-salt and magnesian rocks, and the modes by which potash has been eliminated from it by marine vegetation, and apparently by the formation of glauconite, suggest many important subjects of inquiry which I reserve for another occasion.

The history of our globe, especially during the time when chemical forces were yet in the ascendant, and were preparing it for the reign of organic life, offers considerations of great interest which I hope soon to be able to develop at greater length than I have done in these few lines.

9. *On the Amount and Frequency of the Magnetic Disturbances and of the Aurora at Point Barrow, on the Shores of the Polar Sea;* by Major General SABINE (Proc. Brit. Assoc., Athen., No. 1559).—Point Barrow is the most northern cape of that part of the American continent which lies between Behring's Strait and the Makenzie River. It was the station of H. M. S. Plover from the summer of 1852 to the summer of 1854, and to the Captain, Maguire, now in the Section, and officers of that ship, they were indebted for the very valuable series of observations which he was now about to lay before the Section, and in part discuss. They were furnished with supplies of provisions, &c. for Sir John Frank-

lin's ships, had they succeeded in making their way through the land-locked and ice-encumbered channel, through which they sought to effect a passage from the Atlantic to the Pacific. In this most dreary and otherwise uninteresting abode, Capt. Maguire and his officers happily found occupation during seventeen months, unremittingly, in observing and recording every hour the variations of the magnetic and concomitant natural phenomena, in a locality perhaps one of the most important on the globe for such investigations. Their observatory, placed on the sand of the shore, which for a long tract nowhere rose much over five feet above the sea, was constructed of slabs of ice, and lined throughout with seal-skins. The instruments had been supplied by the Woolwich establishment, with the requisite instructions for their use; and the observations were made and recorded precisely in the same manner as those of the Colonial magnetic observatories. These were sent by Capt. Maguire to the Admiralty, and were in due course transmitted to General Sabine, by whom they were subjected to the same processes of reduction as those made in the Colonial observatories.

The author then exhibited to the Section six long rolls, containing the results of this discussion, giving the reduced observations at each of the hours of the twenty-four. A sufficient body of the larger disturbances having been separated from the rest, it was found at Point Barrow as elsewhere, wherever similar investigations had been made, that in regard to the frequency of their occurrence, and the average amounts of easterly and westerly deflections, the disturbances followed systematic laws depending on the hours of solar time. The laws of the easterly and westerly were also found at Point Barrow, as elsewhere, to be distinct and dissimilar. The author explained how these observations, which manifestly related to those arising from what were called "storm," were separated from the rest; and when that separation was effected, the law of the true solar variation was shown distinctly to be observed. But upon instituting a comparison between the disturbance laws at Point Barrow and Toronto, it was found that the laws of the deflections of the same name at the two stations did not correspond; but, on the other hand, there existed a very striking and remarkable correspondence between the law observed by the easterly at Point Barrow and the westerly at Toronto, and between the law of the westerly at Point Barrow and easterly at Toronto; and this correspondence was shown to exist not in slight or occasional particulars only, but throughout all the hours in well-marked characteristics of both classes of phenomena; and it follows from the correspondence in the hours at which opposite disturbance deflections prevail, that the portion of the diurnal variation which depends upon the disturbances, has opposite, or nearly opposite, characteristics at the two stations. The importance of eliminating these disturbances from the regular march of the solar variation was then pointed out in both: for when the diurnal variation is derived from the whole body of observations at Point Barrow, retaining the disturbances, the westerly extreme of the diurnal excursion, which, as is well known, occurs generally in the extra-tropical part of the northern hemisphere a little after 1 P.M., is found to take place at 11 P.M.; but when these larger disturbances are omitted, the westerly extreme falls at the same time as elsewhere—viz.,

.M.; and the author suggested the probability that the anomalies ch have sometimes been supposed to exist in the turning hours of the r diurnal variation in high latitudes may be susceptible of a similar lanation. It appears, then, by a comparison of the Point Barrow and onto observations, that in the regular solar diurnal variation the prosion at the two stations is similar, the easterly and westerly extremes ig each reached nearly at the same hours, whilst in the disturbance nal variation this progression is reversed. Another distinction exists heir magnitudes, which is found in the solar diurnal variation to be early as may be in the inverse ratio of the values of the horizontal e at the two stations, (which is the antagonistic force opposing all netic variations,) whilst on the other hand the increase in the range he disturbance variation is many times greater than it would be acling to the same proportion. It would appear, therefore, that the olute disturbing force must be greater at Point Barrow that at Toronto. he author then proceeded to point out the concomitant occurrences e auroral manifestations. The observers noted at each hour whether ot there was an auroral display: from 11 A.M. to 3 P.M. no auroral lays were ever observed; but the number of them was found progresly to increase from 3 P.M. to 1 A.M., and then again in regular prosion to decrease to 0, at 11 A.M. The frequency of the occurrence he aurora may be judged of, when it is said that during six months, ecember, January and February of 1852–53, and the same of 3–54,—the aurora was seen six days out of every seven. The hour he day at which no auroral display is ever observed corresponds with minimum of westerly disturbance, while the maximum of both is d at the same hour of westerly disturbance—viz., 1 A.M. The frency of the aurora, also, and the amount of westerly deflection of the gnet also accord; whilst on the other hand the auroral hours appear ave little or nothing in common with the turning hours or the prosion of the easterly deflection.

Vhen Sir John Franklin was going out on the expedition which deed his country of the invaluable services of himself and his brave panions, he had been furnished by the Admiralty both with instruts carefully adjusted and compared with standards, and with full inctions for their use, and for the making and recording hourly observas of the utmost importance in the several stations he might occupy in e seas; and in the last letter which had ever been received from him, had expressed his determination to put up those instruments at the eral stations at which he should winter. Now when his ardor in these suits and that of Capt. Crozier, the second in command, and the other cers, were taken into account, there could remain no doubt that such ervations had been made and recorded, and that these records still exd in some of the places he had last been in. When he (General ine) was with Capt. Parry, in 1818, they had made observations with pendulum for determining the figure of the earth, and others of great ntific importance, on their way towards Behring's Straits. They had n exposed to considerable risk of the ships being lost, and were about ake to the boats and proceed overland, and in preparation for this ely prepared to carry with them abstracts of the observations, leaving

the original full records safely deposited in secure cases in the cabins of the ships, to be found by those who doubtless would be sent out to look for them. He had, therefore, no doubt that if the ships of Sir John Franklin were still in existence, in their cabins were to be found those scientific treasures; and this was one of the reasons why men of science were so anxious to have the ships carefully looked for, and it was a sacred duty even to the memories of those who had sacrificed their lives in procuring such results to do them the justice and honor of having them recovered if possible.

At the conclusion of General Sabine's address, the President requested Capt. MAGUIRE to favor the Section with a portion of what he had observed in these most inhospitable, but, to the scientific inquirer, deeply interesting regions. Capt. Maguire, with that modesty so characteristic of the British sailor, disclaimed for himself much merit, and assigned all the praise of making and recording these hourly observations, through such a very lengthened period, to his brother officers, he himself only occasionally helping, particularly when he was out with exploring parties. He said he much wished he could convey to the Section any vivid impression of the beauty and brilliancy of the auroral displays in those regions. It was never seen during the hours of daylight, or those hours which corresponded to mid-day, but towards evening its displays began, at first towards the north; it then extended in splendid arches spanning the entire sky, and seeming to end in beautiful coronæ towards the zenith; these were occasionally of the most brilliant and varied tints and colors. It spread gradually more south, and at length died away towards the morning hours in the south. Such were the beauty and interest o these displays, that men and officers constantly, with the thermometer at and below 40° below zero, stood out for hours witnessing the glorious scene. During these auroral displays he could not say that he had ever witnessed those violent agitations of the needle that others had described, but the easterly disturbance of the variation seemed to be simultaneous with its northerly display, and the westerly to its influence when it had passed to the south. At some distance from the ships, say about five miles, the water shoaled, and the ice had been driven up into beautiful rocky pinnacles; beyond this, again, the water was always free of ice, and its temperature was frequently found to be 28° above zero, when that of the air above was even 40° below zero; the consequence was, that it had all the appearance of a boiling sea, so great was the quantity of vapor thrown up from it.

Admiral FITZ-ROY, Mr. GASSIOT, and other members of the Section, spoke of the most important interest which these inquiries had in a scientific point of view, and could not help thinking that if the Admiralty had been more strongly pressed upon the subject, they would not have persevered in declining to aid in the expedition which had gone out this year.

10. *On the Direction of Gravity at the Earth's Surface;* by Prof. HENNESSY (Proc. Brit. Assoc., Athen., No. 1589).—If the earth's surface be considered to coincide with that of the liquid which covers three-fourths of the entire spheroid, gravity should be considered as perpendicular to it at every point. If, however, the earth were stripped of all its seas and

oceans, the surface would present considerable inequalities. From what is now known regarding the depth of the ocean, the continents would appear as plateaus elevated above the oceanic depressions to an amount which, although small compared to the earth's radius, would be considerable when compared to its outswelling at the equator, and its flattening towards the poles. The surface thus presented would be the true surface of the earth, and would not be perpendicular to gravity. If a kind of mean surface be conceived intersecting this, so as to leave equal volumes above of elevations, and of depressions below it, it is not allowable to assume that such a surface is perpendicular to gravity. The mean surface of the solid crust of the earth would not be perpendicular to gravity, if, after the process of solidification had commenced, any extensive changes in the distribution of matter in the earth's interior could take place. If the fluid matter in solidifying underwent no change of volume, the forms of the strata of equal density within the earth would be the same at every stage of its solidification. But if, as observation indicates, such fused matter, on passing to the solid crystalline state, should diminish in volume, the pressure on the remaining strata of the fluid would be relieved, and they would tend to assume a greater ellipticity than they had when existing under a greater pressure. The general result of this action would manifestly be to produce a change in the direction of the attractive forces at the outer surface of the solid crust. The direction of a plumb-line would be slightly altered so as slightly to increase the apparent latitudes of places over a zone intermediate between the equator and poles.

M. D'Abbadie stated several cases which he had met with, where monuments existed which showed that the direction of gravity at some former period must have been very different in relation to these particular portions of the earth from what it now was. Other members also noticed deviations of the plumb-line from its normal position, and some of them which seemed to depend on the season of the year.

The President, Dr. Robinson, stated that he was the first to direct attention to those changes of level which depended on the season of the year. This he was led to observe from the fact, that the entire mass of rock and hill on which the Armagh Observatory was erected was found to be slightly, but to an astronomer quite perceptibly, tilted or canted at one season to the east, at another to the west. This he had at first attributed to the varying power of the sun's radiation to heat and expand the rock throughout the year; but he since has had reason to attribute it rather to the infiltration of water to the parts where the clayslate and limestone rocks meet. The varying quantity of this through the year he now believed exercised a powerful hydrostatic energy, by which the position of the rock was slightly varied.

II. MINERALOGY AND GEOLOGY.

1. *Brucite at Wood's Mine, Chester Co., Pennsylvania.*—In a letter from Dr. W. D. Hartmann of Westchester, Pa., he states that Brucite occurs at Wood's Mine in seams in serpentine from one to four inches in width. The mineral is broad foliated, folia several inches square being easily obtained, and either opaque silvery white or translucent to transparent. Occasionally it has a fine rose tint. The vein has an outer layer of a greenish chlorite-like mineral.

2. *Descriptions of New Species of Palæozoic Fossils from the Lower Helderberg, Oriskany Sandstone, Upper Helderberg, Hamilton and Chemung Groups;* by JAMES HALL. 146 pp. with wood-cuts. Extracted from the Report of the Regents of the University. Albany, 1857.—This pamphlet is issued by the State in advance of the third and fourth quarto volumes on the Palæontology by Prof. Hall, of which the third is now nearly ready. It contains a large number of new species, though but a part of what those volumes will embrace. Prof. Hall here adopts Suess's genus Meganteris, and the *Atrypa elongata* of Conrad characteristic of the Oriskany Sandstone (*Terebratula ovoides* of Eaton in his Geol. Text-book, 1832), is named the *Meganteris ovoides;* and the *Pentamerus elongatus* of Conrad from the Onondaga limestone, is the *Meganteris elongatus.*

The pamphlet closes with a short paper by Mr. Hall on his genus Tellinomya (see Pal. N. Y., vol. i). The paper was published originally in the "Canadian Naturalist and Geologist." From recently discovered specimens, he has found that the teeth of the hinge have a close relation to those of the genus Nucula, and he is enabled to give the following corrected description:—

TELLINOMYA.—Shell equivalve, equilateral or subequilateral, closed, smooth or marked by lines of growth, ligament external; hinge-line curved, sometimes subangular, with a continuous series of small curved transverse teeth, which diminish from the extremities to the beak, beneath which, they are much smaller. Muscular impressions double, two anterior and two posterior, one large and strongly impressed, the other smaller, lying above and between the larger one and the hinge-line; pallial impression simple.

He refers to it, *Ctenodonta* of Salter.

3. *Cosmogony, or the Mysteries of Creation;* by THOS. A. DAVIES. 416 pp., 8vo. New York.—There is quite an extensive show of science through this large volume, but by one ludicrously ignorant of its first principles and correspondingly presumptuous. The following are some of the sage conclusions argued out from the author's scientific materials: That the theory that boulders or rounded stones are water-worn rocks "is entirely untenable;"—that all "vegetable mould was made undoubtedly in connection with the vegetable kingdom in the primitive creation," and that we may as well say milk comes from granite as ingredients that improve or make soils;—that fossil bones and shells, ancient sea beaches and ripple marks, etc., are primitive creations, spoken into existence as they are, as types of future existences;—that the coal of all coal beds "must be the slow but mysterious carbonization of the clay slates!" Similar views (the *last* excepted) in the biblical scholar not claiming any knowledge of science should have respectful consideration; but not so, when the product of scientific pretense.

We have quoted a few of the surface ideas only of the work. Its philosophy makes profound plunges; and one of the jewels of knowledge gathered from the mud, to which a page of capitals is wholly devoted, is the order in which the laws of matter were established in the course of the first four days of creation:—namely, Attraction of Gravitation *after* Form, Color, Electric Attraction, Cohesive Attraction, Endosmosis and

Exosmosis; Electric attraction, etc. *after* Chemical affinity; Chemical affinity *after* Aggregated Existence; and Motion and Equilibrium *last.*

The author is to be commended for his desire to sustain sacred truth; but he has made a stupid book that will damage the cause.

4. *On the Existence of Forces capable of changing the Sea level during different Geological Epochs;* by Prof. Hennessy (Proc. Brit. Assoc., Athen., No. 1559).—If, in assuming its present state from an anterior condition of entire fluidity, the matter composing the crust of the earth underwent no change of volume, the direction of gravity at the earth's surface would remain unchanged, and consequently the general figure of the liquid coating of our planet. If, on the contrary, as we have reason to believe, a change of volume should accompany the change of state of the materials of the earth from fluidity to solidity, the mean depth of the ocean would undergo gradual though small changes over its entire extent at successive geological epochs. This result is easily deduced from the general views contained in other writings of the author, whence it appears, that if the surface stratum of the internal fluid nucleus of the earth should contract when passing to the solid state, a tendency would exist to increase the ellipticity of the liquid covering of the outer surface of the crust. A very small change of ellipticity would suffice to lay bare or submerge extensive tracts of the globe. If, for example, the mean ellipticity of the ocean increased from $\frac{1}{300}$ to $\frac{1}{299}$, the level of the sea would be raised at the equator by about 228 feet, while under the parallel of 52° it would be depressed by 196 feet. Shallow seas and banks in the latitudes of the British isles, and between them and the pole, would thus be converted into dry land, while low-lying plains and islands near the equator would be submerged. If similar phenomena occurred during early periods of geological history, they would manifestly influence the distribution of land and water during these periods, and with such a direction of the forces as that referred to, they would tend to increase the proportion of land in the polar and temperate regions of the earth, as compared with the equatorial regions during successive geological epochs. Such maps as those published by Sir Charles Lyell on the distribution of land and water in Europe during the tertiary period, and those of M. Elie de Beaumont, contained in Beudant's 'Geology,' would, if sufficiently extended, assist in verifying or disproving these views.

III. BOTANY AND ZOOLOGY.

1. *Monographie de la Famille des Urticées;* par H. A. Weddell (Archives du Muséum, tom. ix, livr. 1–4), 4to, 1856–7.—Dr. Weddell's preliminary studies upon the proper *Urticaceæ* were published a few years ago in the *Annales des Sciences Naturelles.* Since then, botanists, aware from this and his other works that the subject was in most able hands, have been anxiously waiting for his full monograph. This, we understand, is now completed, although the last fasciculus has not yet reached this country. The greater part is before us, and an admirable monograph it is, worthy of a place in the *Archives* which contain that model one on the *Malpighiaceæ* of his lamented botanical master. It illustrates in detail about 470 species, under 40 genera, and is accompanied by 20 well-filled plates, drawn by the author. It opens with a Con-

spectus of the members of the great group to which the true *Urticaceæ* belong (which the author inclines to receive rather as the orders of a class than as suborders of an extensive order, fully admitting, however, their close affinity *inter se*), followed by a brief indication of the principal investigators of these plants, and of the resources at his own command. A general account of the organs of vegetation and reproduction, of the affinities, of the geographical distribution of the plants of the group, and of their properties and uses, conclude the preliminary matter. The body of the work is occupied by their systematic arrangement and description.

Apetalæ being viewed as degenerations of *Polypetalæ*, our author searches among the latter orders for the nearest relatives of the great Urticaceous order or alliance, and finds them in the *Tiliaceæ*, that is, in the group of orders of which the *Malvaceæ* are the highest development. According to Weddell's happy illustration, *Malvaceæ* crown the summit of a three sided pyramid, with *Sterculiaceæ*, *Byttneriaceæ*, and *Tiliaceæ* just below them, one upon each face; under the *Byttneriaceæ* he ranks the *Euphorbiaceæ* with the *Antidesmeæ*, and under these, at the very base of the pyramid, the *Scepaceæ*, the lowest degradation in this direction of the *Malvaceous* type. On the adjacent face, under the Tiliaceæ, and on the same level with the Euphorbiaceæ he inscribes the *Urticaceæ*, with the *Cupuliferæ* perhaps underneath them. Upon this ingenious plan of representation, the apetalous orders throughout may be most conveniently and instructively ranked under their superior types;—bearing in mind that some types degrade as much within an order (e. g. *Euphorbiaceæ*, *Onagraceæ* inclusive of *Halorageæ*, *Caryophyllaceæ* including *Illecebreæ*) as others do through a series of two or three orders, or even as the same group does (e. g. *Caryophyllaceæ*) through a series of orders on the other sides of the pyramid.

The reason why this mode of representation will exhibit botanical affinities so well is, that (as we have elsewhere remarked) the vegetable kingdom does not culminate,—as the animal kingdom does,—and therefore offers no foundation whatever in nature for a lineal arrangement even of its great groups. But it would appear that the *Dicotyledonous* orders might be arranged under a considerable number of short series, in groups converging upon the most fully developed or representative order of each type, so as to exhibit what we now know of the system of nature much better than in any other way.

We think that Dr. Weddell's idea of the affinity of *Urticaceæ* is a good one. The floral and seminal characters, the true *criteria* of affinity are not abhorrent, but present some strong points of relationship, as do the organs of vegetation. These, once established, allow us to feel the force of the striking coincidence in the bast-tissue of the bark, so remarkable in all this alliance for the length, fineness, and toughness of the fibres, their union end to end, and their lateral independence, admirably adapting them for their use as textile materials, in which *Urticaceæ* vie with *Malvaceæ* and *Tiliaceæ*.

As to geographical distribution, Europe is very poor in *Urticeæ*, poorer even than would at first view be supposed, as the author remarks. For as nettles like an enriched soil, the five or six European species of *Urtica* and *Parietaria* so abound around habitations that they make up in the

multitude of individuals for the paucity of species, and perhaps cover nearly as much ground as the great number of intertropical species; two or three excepted, which also are weeds in the tropics. Temperate North America is not much richer in species than Europe. The greater part are found in the torrid zone, and in islands rather than continents; the Malay region, India, Mexico, and the West Indies together possess almost two-thirds of the known species.

Our remaining remarks shall be restricted to one well-known plant described in the work, and to another, of recent discovery, which unfortunately was not communicated in season to find a place in it.

The first is our common *Pilea pumila.* Dr. Weddell has overlooked the fact that Rafinesque had founded a genus (*Adice* or *Adike*) upon it, although the name is mentioned in the work, cited by him, where the plant was first published as a *Pilea*, and although Dr. Torrey had adopted Rafinesque's genus, and figured the species, in an earlier and more considerable work (*Flora of the State of New York*), which, having unfortunately been published by the State, and in a large edition, has in consequence remained almost unknown to science. Considering that the three sepals of the fertile flower in this species are nearly equal and not gibbous, it may be doubted whether the single species of Blume's genus *Achudemia*, differing only in having five sepals, should not rather be appended to *Pilea.* We dare say that Dr. Weddell would have so arranged it, if Blume had not published the genus.

Since the appearance of the third part of Weddell's monograph, but before it had reached this country, Dr. Torrey has published, in the Report on Dr. Bigelow's fine California collection made in Lieut. Whipple's Railroad Survey to the Pacific, a new Nettle, allied to *Bœhmeria* but with the penicillate stigma of *Urtica*, viz. his *Hesperocnide tenella* (Pacific R. R. Reports, 4, p. 139). This little plant, it now appears, comes nearest to Wight's monotypic genus *Chamæbaina* of India, of which better details than Wight's as to the female flowers and fruit are figured in the present monograph. The stigma is intermediate in character between that of *Chamæbaina* and that of *Urtica;* and, moreover, as the sepals of the male flower want the pointed gibbous tips of the former, the stipules are inconspicuous, and the cotyledons are not only reniform but (which is unnoticed in the published description) pretty strongly emarginate at the summit also, the genus will probably be retained.

Great thanks are due to Dr. Weddell for his labors upon this family, which he found in a most unsatisfactory and difficult state, and has left in such condition that Nettles and their allies are easy and inviting objects of study. Meanwhile, his other undertakings are carried on with spirit. Of his *Chloris Andina*, a flora of the higher Andes, three fasciculi have reached us since our former notice of the work, and we understand that the first volume is completed. In this work the author handles the *Compositæ* with marked ability. A. G.

2. *Miquel's Flora van Nederlandsch Indië*, or *Flora Indiæ Batavæ*,—for it has both Dutch and Latin title-pages, has made no small progress since our former notice of the work. Five parts (864 pages) have appeared of the first volume, which is devoted to the *Dicotyledones Polypetalæ* and *Apetalæ* conjoined; and one more fasciculus will apparently

complete this volume. The second, devoted to the *Monopetalæ* has extended to the third fasciculus. Thus far it is mainly occupied with the *Compositæ*, *Rubiaceæ*, *Apocyneæ* and *Asclepiadeæ*. Meanwhile the indefatigable author has issued two parts of the third volume, devoted to the *Monocotyledones*. The work appears to be faithfully elaborated, and must be highly useful to systematic botanists and creditable to the author.

A. G.

3. *Walpers: Annales Botanices Systematicæ.*—The second fasciculus of Dr. Mueller's continuation of this work has come to hand. It extends only from the *Nymphæaceæ* to the *Sterculiaceæ*,—at which rate a series of volumes will be required to bring up the arrears of scattered species published since the year 1850. A. G.

4. *Jahrbücher für Wissenschaftliche Botanik: herausg. von* Dr. N. PRINGSHEIM. Berlin. Vol. I, part 1, 1857, large 8vo, pp. 138, with 10 plates.—This new work is to be devoted to original articles upon scientific botany in the strictest sense, and especially to the departments in which its editor is so distinguished, viz. Vegetable Anatomy and Morphology. The first article is by Dr. Pringsheim himself, one of a series of contributions to the Morphology and Classification of *Algæ*. It is a complete investigation of the morphology and development of the *Œdogonieæ* (*Œdogonium* and *Bulbochæte*) illustrated by six colored plates. The very important and curious results of Pringsheim's investigations upon the development and fructification of the lower Algæ, need to be presented in connexion with the contemporary ones of Cohn and Braun, which together have thrown new light upon this part of vegetable physiology, demonstrating that their reproduction is as truly sexual as that of higher plants and more directly comparable with that of animals.

The remainder of this fasciculus is occupied by New Researches upon the formation of the Embryo of Phanerogamous Plants, by Hofmeister, of Leipsic, with four plates:—one of them illustrating the impregnation and development of the embryo of a Balanophoraceous plant, *Cynomorium*. He thinks that in some cases traces of a cell-wall may be detected upon the germinal vesicle anterior to their fecundation by the pollen.

A. G.

5. *Radlkofer; on The Process of Fecundation in the Vegetable Kingdom, and its relation to that in the Animal Kingdom* (Leipsic, 1857, 8vo). Translated by ARTHUR HENFREY, F.R.S., &c., and published in the Annals and Magazine of Natural History for October and November, 1857.—This gives in English, and in an accessible form, a systematic and historical survey of the whole subject of vegetable fecundation, including the recent discoveries of Pringsheim, Cohn, Braun, and Bary, referred to in our previous article.

As to *Fungi* and *Lichenes*,—thanks to the observations of Itzigsohn upon the latter, and the most careful and persevering investigations of Tulasne upon both families,—the analogues of male organs in all probability are discovered, and their general presence recognized; but the fact of fecundation is not made out.

In the lower or green *Algæ*, fecundation was first *demonstrated* by Pringsheim. The "horns" of *Vaucheria* which Vaucher half a century ago observed and conjectured to be male organs, Pringsheim proved to

ıaving seen them open at the summit and emit a great number of ;ing corpuscles (spermatozoids), many of which found their way : now open orifice of the protuberance which contains the forming nd were seen crowding against it, after which a membrane of celppears over the surface of the mass of protoplasm and completes re. Whether one or more of the spermatozoids actually peneıe protoplasm and so is included within the cell-membrane is un; but Pringsheim thought it was the case, from having detected a s corpuscle like one of the spermatozoids inside of the membrane. 'ringsheim demonstrated a similar fecundation in *Œdogonium.* ılts, briefly published in the Proceedings of the Berlin Academy, nce translated into French and English, are now given in detail in : part of his *Jahrbücher*, noticed above. *Œdogonium* consists of f cylindrical cells. Some of these cells, usually shorter than the come tumid, and, without conjugation, have their whole green s transformed into a large spore. Pringsheim has ascertained that ells of the same individual plant have their green contents transinto a multitude of active corpuscles or zoospores, which, from bsequent evolution and office, he names *androspores:* these escape opening of the mother cell, moving about freely by the vibration ɔwn of cilia attached near the smaller end. One or more of these ores fix themselves by the smaller end upon the surface of the which a large ordinary spore is forming, or in the vicinity, and ate there, growing longer and narrower at the point of attachment, ıear the free end a cross partition forms, and sometimes another, ; one or two small cells; this is the true antheridium; for in it a ɔf spermatozoids are formed, also endowed with motivity by means atile cilia. Now the top of the antheridium falls off as a lid, the tozoids escape; the spore-cell at this time opens at the top; one spermatozoids enters the opening, its pointed end foremost; this s stationary upon or slightly penetrates the surface of the young nto which its contents are doubtless transferred, and a coat of cel; then, but not till then, deposited upon it, completing its organiıs a spore, which in due time germinates, and grows directly into like the parent.

in *Bulbochæte*, and especially in *Sphæroplea*, so beautifully invesby Cohn (see Ann. Sci. Nat., ser. 4, vol. 5), the spore does not develop into the normal or fruit-bearing plant. Instead of this, ılternation of generations (to adopt that well-understood phrase), re proceeds to convert its contents by successive division into a large · of zoospores, different from the androspores, viz. small, oval or bodies, furnished with two long cilia on a short beak at one end, a time moving actively about by their vibration. Coming to rest ɔospores germinate, by elongation and the formation of transverse ns, into adult thread-like plants, consisting of a row of cells. In ɔplea the whole contents of the cells of some adult individuals conıto large green spores, as yet without a coat; while those of difndividuals give rise to myriads of slender spermatozoids, moving ns of a pair of cilia fixed at the narrow end. The latter escape .e parent cell through a small perforation which now appears,

enter the spore-bearing cells of the fertile plant through a similar perforation in them, play around the spores, and at length one or more of them drives its pointed extremity into their naked surface; after which, fertilization being accomplished, a thick coat of cellulose is deposited to complete the spore. "Cohn does not consider that observations justify his assuming a direct penetration of the spermatozoids into the primordial spore-cell. It rather reemed to him as if they attached themselves on the outside of the spore, and were finally converted into mucilaginous globules."

Reproduction by conjugation of course had long been familiarly known in the lower *Algæ*. But it was questioned whether this was really analogous to sexual reproduction, since what appeared to be similar spores are often formed of the contents of a single cell without conjugation. Areschoug shows that these are abortive spores, incapable of germination; while those which result from actual conjugation will grow into new plants, without further metamorphosis, Vaucher's old observations to this effect having been confirmed by Braun and Pringsheim.

That in the *Fucaceæ* or olive-green *Algæ*, the large spores are fecundated by spermatozoids, produced in antheridia, was demonstrated by Thuret in the year 1850. And in more recent memoirs he has shown that the fertilization takes place through direct contact of the spermatozoids with the naked surface of the unimpregnated spore, then having only a protoplasmic coating; and that these spores will not develop nor hardly acquire a cell-wall unless so fertilized. His experiments upon diœcious species are perfectly decisive upon these points. He observed the lively spermatozoids playing over the surface of the still-naked spore, fix themselves to it by the ciliated end, apparently by one of the cilia, and at length come to rest in contact with it; but he could not detect any material penetration of them into the body of the spore. Pringsheim, confirming all Thuret's observations, also thinks that the spermatozoids actually penetrate the spore-mass; but there is no direct proof of it. Indeed Thuret, in a very recent article (in Ann. Sci. Nat., ser. 4, vol. 7, 1857,) indicates the grounds of Pringsheim's probable mistake. The most interesting point in this last article by Thuret relates to the suddenness with which the cell-membrane is formed on the spore of *Fucus* after the access of the spermatozoids and the accomplishment of the act of fecundation. In six or eight minutes traces of the formation of the membrane are recognizable upon a considerable number of the spores. In ten minutes the presence of a membrane, may be clearly made manifest by the application of chlorid of zinc. In an hour the membrane has acquired considerable firmness and thickness, and the presence of cellulose is revealed by the action of sulphuric acid and iodine: an hour later and the blue coloration under the test is decided.

In the higher *Cryptogamia* and in the *Phanerogamia*, Radlkofer's treatise, though interesting for the history, offers nothing new to our readers. In fact its date precluded it from containing much of what is referred to in the preceding paragraphs. But the subject is still to be continued. A. G.

6. *Natural History of the Spongiadæ.*—J. S. Bowerbank, Esq., of Highbury Grove, London,—eminent in this and related departments of

ɔpical research,—is preparing a general work upon the Sponges, ery desirous of obtaining specimens from this country. The fol-instructions for their collection and transportation are extracted circular issued by Mr. Bowerbank:—

nges are exceedingly various in their external form and appear-hey are either massive, branching, fan-shaped, cup-shaped, or other substances, and are frequently parasitical on horny zoo-r sea-weeds. In substance they are light and elastic, rigid, gela-fleshy, and sometimes hard and stony, and are frequently very colored; and they vary in size from the tenth of an inch in or diameter, to several feet. They are procured by dredging in o or three to several hundred fathoms deep; and they are found derable quantities attached to rocks or sea-weeds, &c., between d low water marks, and in the line of sea-weeds and other mat-own up by the sea at high water mark. In every case the more tain of their fleshy or gelatinous matter the more valuable they hey should never be washed in either salt or fresh water, and y not in the latter, as it makes them hard and brittle. They e dried as speedily as possible, either in a shaded, breezy place or k oven, after having been well drained of salt water; and if at-o small stones or other substances they should be preserved in the state. They may be packed in boxes from one to three feet or, if longer, a partition may be put in; and the best packing is ed sea-weeds that have not been washed in fresh water. The onges should be placed in the cups or hollows of the larger ones, very small or delicate, in chip or card boxes, or a screw of stout Sawdust or cotton should never be used. The box should be and closely packed, but without crushing. In selecting from ted matter at high-tide mark, plenty of horny zoophytes should n, and especially those which are full of parasitical matters, as ve frequently growing on them the most minute and curious of the sponge tribe, and also numerous minute and beautiful If a large stone be appended to the sponge it is best to secure it ner of the box, by boring two or more gimlet holes near the ass a string round the stone and through the holes, and drawing from without, plug the holes and string firmly with wooden d cut off close to the box.

writer would also be *particularly* obliged by specimens of Spon-fresh-water sponges, as he is engaged on a Monograph of that They are found in rivers, lakes or tanks, and pools, attached to od, rocks or stones, and are occasionally found surrounding the of trees, dipping into the water during periodical floods; and if tain their granular, seed-like bodies they are the more valuable. n just as they come from the water. If it be deemed necessary ve parts or the whole of delicate specimens of either marine or er sponges in fluid, the best material is strong spirit, or water *nsiderable* excess of undissolved salt in it, but *never* alum. Jars and fruit bottles, well corked and sealed, or tied over with are the best vessels for the purpose."

The Editors of this Journal, or Prof. Gray of Cambridge, will gladly receive collections of Sponges and Spongillas made in this country, and forward them to Mr. Bowerbank. There are indications of two or more species of Spongilla in our lakes and streams, different from the two European species, and as yet undescribed; and the present opportunity for their thorough investigation should by all means be improved. A. G.

7. *Seeman's Botany of the Voyage of the Herald;* parts IX, and X.—The latter just issued, complete this creditable botanical work. It extends to 483 pages, and to 100 plates, all well chosen and well executed. The 9th fasciculus finishes the collections in North Western Mexico, and give a general introduction to the Flora of Hong Kong: the 10th comprises what purports to be a synopsis of the known plants of this island, 778 in number, a full index to the volume, and 14 pages reprinted to correct errors and give additional information. In one of them is corrected a mistake by which a *Tephrosia* was taken for so peculiar a plant as our *Galactia marginalis*, Benth. The Hong Kong *Compositæ* are elaborated by Dr. Steetz, with his usual conscientious care and good judgment; the *Orchidaceæ* by the younger Reichenbach; the *Cyperaceæ* and *Gramineæ* by Col. Munro; and the *Ferns* by Mr. John Smith. In a neat preface Dr. Seeman takes just credit to himself for having proposed only a very limited number of new genera and species, considering the extent of his collections and the number of little-known countries visited.* He attributes this in a good degree to his having had "the advantage of free access to the largest herbarium in the world, that which the liberality of Sir W. J. Hooker has thrown open to the scientific public; an advantage enabling me to identify most of my plants with already described ones, and preserving botanical literature from a series of synonyms with which under less favorable circumstances, it must and would have been hampered. * * Hence what at first would appear an unfavorable feature, will on second consideration prove perhaps one of the best recommendations of this work." We may add that this advantage would have been of small account, except for the untiring industry of the author and the great knowledge of those who helped him.

Dr. Seeman,—now personally known to the naturalists of the United States, which he has recently visited as the representative of the Linnæan Society to the Montreal meeting of the American Association,—is the editor of the *Bonplandia*, a Botanical Journal, now in the fifth year of its existence, published at Hanover, in monthly numbers, of small folio size. This, we learn is to be enlarged this year, and to contain some floricultural matter. In its new form we trust it will find additional subscribers in this country. The only drawback is the language, of which the German is the staple; but most of the technical matter relating to systematic botany is in Latin; and articles are admitted either in French or in English. A. G.

8. *Dr. J. D. Hooker: On the Structure and Affinities of Balanophoreæ* (separately issued from the *Transactions of the Linnæan Society of*

* To help on a little this laudable diminution of nominal species, we may remark that the only species which Dr. Seeman has proposed as new in the Flora of Western Esquimaux-land (and admirably figured,) viz.: his *Artemisia androsacea*, is doubtless *A. Senjavinensis*, of Besser, from the opposite coast. A. G.

vol. xxii). pp. 68, 4to, 16 plates.—Although read before the Society nearly three years ago, this fine memoir was published summer. The delay has probably been owing, in great part, to requisite for the engraving of the very beautiful and elaborate ich illustrate the memoir. It is a clear, patient, and philosophi- lation of an extremely anomalous group of plants, and a succinct n of the principal lessons to be learned from their study, both aphically and systematically; and it bears the impress through- e spirit, freshness, and independence which so distinguish this nd make all his writings so attractive and instructive. While e subject is developed in proper order, the divisions are not quite arked out in the essay. The first sectional heading is "1. *Para- d Structure of the Rhizome.*" But there is no section 2 answer- ie first, which, moreover continues, without a break, to treat of ·al anatomy, organography, and morphology of these plants, the of the flowers, ovules, and seeds, and of the diverse doctrines ve been propounded respecting them. The *Affinities of Balan-* are then considered, under a special heading; their *Classification* the subject of a few general remarks; also their *Geographical tion and Variation.* Then a Synoptical Table of the genera is nd the 14 genera with their known species (28 in all) are finally . and illustrated.

the structure and affinities of *Balanophoreæ*, and the curious that have arisen about their place in the natural system, Dr. in the first place, affirms them to be truly phænogamous. It now ange that this should ever have been doubted. The arguments ntrary, says our author, "all appear to have originated, on the , in mistaking feeble analogies between the forms of organs that iomologous, for affinities; and, on the other, in overlooking a e of positive characters. These arguments may be summed up An erroneous view of the nature of the seeds, by Endlicher, Blume, and others, who describe them as a sporuliferous mass,— hich, even if it were applicable, has no meaning. 2. An erro- w of their origin being in a diseased state of the plants they on, adopted by Junghuhn and Trattinick. 3. A supposed simi- appearance to *Fungi*, and an erroneous idea that their appear- neteoric and their growth rapid;—a theory advanced by End- ho says of the horizontal rhizome of *Helosis* and *Langsdorffia*, Fungorum quam maxime analogum." 4. The resemblance be- e articulated filaments on the capitula of the *Helosideæ* and the es of *Musci;* and between the pistils of *Balanophoreæ* and the of Mosses; strongly advocated by Griffith and Lindley. 5. The nce of the cellular and vascular tissues in some of their charac- ome of those of Filices, as indicated by Unger and Gœppert. y peculiar view of the nature and relations of the parts of the wer entertained by Weddell; who hence considers *Balanopho-* ether with *Rafflesiaceæ*) to approach nearer to Gymnosperms any other group of plants." Instead of discussing at length which "had the authors who advocate them been sufficiently with specimens and facts they would never have entertained,"

Dr. Hooker merely recalls attention to the essential facts that these plants exhibit true flowers with stamens and pistils, genuine ovules, and even embryo, and so accord in no one particular with Cryptogams. He shows moreover that the embryo is dicotyledonous in the few cases where it is sufficiently developed to manifest the character, and that the stem is constructed upon the exogenous plan. Even with these facts before him Lindley has retained his *Rhizogens*, as "logically a class;" as an intermediate form of organization between *Endogens* and *Thallogens*, and characterized by vegetation rather than fructification. But there is little or nothing really peculiar in their vegetation; and, as Lindley himself reduces the differences to questions of degree, it suffices to say that classes are not founded upon degradation of type, but upon change of type.

Viewing *Balanophoreæ*, then, as degraded members of the Dicotyledonous class, Dr. Hooker follows Brown and Griffith in regarding *Rafflesiaceæ* as near to *Aristolochiaceæ*, and in denying all affinity between these and *Balanophoreæ*. In searching for the affinities of the latter, Dr. Hooker is guided by the sound rule of disregarding "the negative characters, as those may be termed which are founded on the imperfection of organs;" and he takes the most perfectly developed species as the best exponents of the typical structure of any group,—a principle laid down, we believe, by Mr. Brown. This gives a substantial scientific basis for the estimation of affinity. Agreement *in plan of structure* is just what constitutes affinity; agreement in *grade of evolution* may indicate only distant analogy, can indicate only collateral relationship,—not to be neglected, indeed, but in itself of no account in assigning a family to its true position in the system. The principle as applied in the present case leads Dr. Hooker to the conclusion that the nearest relatives of *Balanophoreæ* are the *Halorageæ*, a group itself "consisting for the most part of reduced forms of *Onagrarieæ*," or more strictly speaking, that the link which connects these plants with the higher forms of vegetation is furnished by *Gunnera*. The qualifying phrase above is appropriate; for it is hard to conceive of *Gunnera* with its minute embryo as a reduced *Onagraceæ*, while it is impossible to sever the chain of evidence which binds the genus to *Loudonia* and *Haloragis*. Be this as it may, Dr. Hooker has surely made a happy hit, in seizing upon *Gunnera* as the key to the true affinities of *Balanophoreæ*. Of all the objections that may be urged against this approximation not the strongest, but rather the least valid, in our opinion (so long as the question is one of alliance and not of co-ordination), is that to be derived from the habit and the imperfection of the foliar organs. Any type is liable to have its parasitic phase, and this is generally a degraded one in these respects; the Gesneriaceous has it in *Orobancheæ*, which it might with the greatest propriety include; the Scrophulariaceous graduates insensibly into similar parasitic forms; the Ericaceous has them in *Monotropeæ;* and the Cornaceous or Olacaceous degrades through *Santalaceæ* into *Loranthaceæ*.

It is quite probable that our author would deny the *degradation* in the latter case, judging from some points which he makes when considering whether the group of *Balanophoreæ*, "putting aside any consideration of its relationship with other orders, and regarding it *per se*, ... should abstractedly be considered as ranking high, or the contrary." This is an

of which we are hardly capable,—that of determining the ı order *per se.* Still our author's ideas are clear and clearly the comparison is really between these plants and the ideal And what is wanting to make the comparison practical is a ı as to what constitutes the highest style of plant, and what is ; importance of deviations from it;—questions too large to be on here, if indeed the science is yet ready for their discussion, underlie the most important inquiries which good systematic ıre everywhere tentatively prosecuting. "Assuming that the ıal definition of perfection in use among zoologists is applicable ;table kingdom, and which argues that a high degree of speci- organs and morphological differentiation of them for the per- of the highest functions, indicate a high rank, Dr. Hooker y argues that "*Balanophoreæ* may in some respects be consid- ld a very high one;" and the points are presented under seven ow we will not deny that the principles are logically applied ;sent case, nor that considerations of the kind are perhaps as to the vegetable as to the animal kingdom. But we should xpect that principles of fundamental importance in the latter ; no sound application to the former; that even such as relate ıs common to the two, or to structures analogous, would require ;d each upon its own ground. As to morphology, and as to ıtitutes perfection of type, we should look to the fundamental ; rather than to the resemblance of the two for our starting

for obvious reasons, are constructed on the principle of extension Concentration or consolidation, wherever it occurs in the veg- ıgdom, is a special provision against some peculiar danger. on the contrary, are formed on the principle of restriction of As if to withdraw them as much as practicable from the direct the external world, their shape is compact, their extent as indi- ·ictly limited, the external organs by which they take their sus- ›mparatively few and small, while the most essential organs are ltered within. Consolidation of organs and even their restriction ·, accordingly are not likely to be indications of high rank in ıble kingdom. Not the latter, because the object of the plant ion is attained by the indefinite repetition of the same organs; rmer, for the type of the plant is realized only in the distinct ›n of leaves from the axis. A Melon-Cactus, and a Cuscuta are of plants as to vegetation. As it is a fundamental character that their organs of reproduction are only specialized organs of ı; as the higher great divisions of plants are those in which the s most apparent throughout; as the perfect accomplishment of ı view,—the production, protection, and nourishment of the em- of the highest or most developed kind,—does not require the ; of homogeneous parts, why should such confluence be regarded ing higher rank, merely because the type is more disguised in ı? We see no sufficient ground for ranking a monopetalous her than a polypetalous one on that account; and still less for ' a *Loranthus* or a *Viscum* as the highest style of plant. On

the contrary, we incline to look upon the consolidation of heterogeneous parts in the blossom not as high specialization at all, but as want of development, i. e. imperfect elimination; and in this light those who maintain an inferior ovary to be one immersed in a receptacle, must needs regard it.

Again suppression or abortion of organs which belong to the type of the blossom cannot be considered as other than an imperfection, although the loss of the corolla is no great matter, and the abortion of one of the sexes little more. Still hermaphroditism is plainly in the type of the highest style of plant; while the opposite is the case in the animal kingdom. But we cannot here enter further into the discussion of this class of questions. No one feels more deeply than our author the want of fixed and philosophical principles for the subordination of characters and the study of affinities in plants; and no botanist of his age is more competent, or so well placed and furnished for the investigation of this problem, to which we invite him, as to a task worthy of his powers.

As to the rank of *Balanophoreæ*, if our author has demonstrated anything, it is that they belong to the highest class of plants, but that they are probably the most degraded members of it. A. G.

9. *Boussingault: Researches upon the influence which assimilable nitrogen in manures exerts upon the production of vegetable matter, and* (2.) *Upon the quantity of nitrates contained in the soil and in water of various kinds* (Ann. Sci. Naturelles, ser. 4, vol. 7, No. 1, 1857).—Several years ago Boussingault demonstrated, in the clearest way, that plants are incapable of assimilating the free nitrogen of the atmosphere. Two years ago, in a paper communicated to the French Academy of Sciences, he showed that nitrates eminently favor vegetation. He now shows, by decisive experiments,

(1.) That the amount even of ternary vegetable matter produced by a plant depends absolutely upon the supply of assimilable nitrogen (ammonia and nitrates). A plant, such as a sunflower, with a rather large seed, may grow in a soil of recently calcined brick, watered with pure water, so far as even to complete itself by a blossom; but it will only have trebled or quadrupled the amount of vegetable matter it had to begin with in the seed. In the experiments, the seeds weighing 0·107 grammes, in three months of vegetation formed plants which when dried weighed only 0·392 grammes,—a little more than trebling their weight. The carbon they had acquired from the decomposition of carbonic acid of the air was only 0·114 grammes; the nitrogen they had assimilated from the air in three months was only 0·0025 grammes.

(2.) Phosphate of lime, alkaline salts and earthy matters indispensable to the constitution of plants exert no appreciable action upon vegetation, except when accompanied by matters capable of furnishing assimilable nitrogen. Two plants of the same kind, grown under the same conditions as above, but with the perfectly sterile soil adequately supplied with phosphate of lime, alkali in the form of bicarbonate of potash, and silex from the ashes of grasses, resulted in only 0·498 grammes of dried vegetable matter, from seeds weighing 0·107 grammes; and had acquired only 0·0027 grammes of nitrogen beyond what was in the seeds.

(3.) But nitrate of potash furnishing assimilable nitrogen, associated with phosphate of lime and silicate of potash, forms a complete manure, and suffices for the full development of vegetation. Parallel experiments with nitrate in place of bicarbonate of potash, resulted in the vigorous growth of the sunflower plants, and the formation of 21·248 grams of organic matter, from seeds weighing as before only 0·107. This 21·111 grams of new vegetable matter, produced in three months of vegetation, contained 8·444 of carbon derived from the carbonic acid of the air, and 0·1666 grams of nitrogen. The 1·4 grams of nitrate of potash supplied to the soil contained, 0·1969 grams of nitrogen, leaving a balance of 0·0303, nearly all of which was found unappropriated in the soil.

Finally Boussingault made a neat series of comparative experiments, introducing into calcined sand the same amount of phosphate of lime and carbonate of potash, but different proportions of nitrate of soda, or in other words of assimilable nitrogen, and watering with water free from ammonia but containing a quarter of its volume of carbonic acid. The soil divided among four pots, each having two seeds of sunflower, (*H. argophyllus* was the species used in all the experiments); the pot

No. 1	received of	nitrate of soda,	0·00	grams.
" 2	"	"	0·02	"
" 3	"	"	0·04	"
" 4	"	"	0·16	"

The results of fifty days vegetation are given in the rate of growth, size and number of the leaves, weight of the product, &c.:

No. 1	made of new vegetable matter	0·397	grams.
" 2	"	0·720	"
" 3	"	1·130	"
" 4	"	3·280	"

In No. 2 so little as three milligrams of assimilable nitrogen introduced into the soil enabled the plant to double the amount of organic matter. The proportion of the weight of the seeds to that of the plant formed was in

No. 1,	as	1 : 4·6 gr.
" 2,	"	1 : 7·6
" 3,	"	1 : 11·3
" 4,	"	1 : 30·8.

In no case did the nitrogen acquired by the plant exceed that of the nitrate added to the soil.

In the experiments where no nitrate was added to the soil, the two or three milligrams of nitrogen acquired by the plants during three months of vegetation, came in all probability from ammoniacal vapors and nitrates existing or formed in the atmosphere. To establish their presence, Boussingault arranged an apparatus which detected the production of some nitrates. And, in exposing to the air 500 grams of calcined sand, which had 10 grams of oxalic acid mixed with it, in a glass vessel with an open surface equal to that of one of the flower-pots used in the above experiments, the sand took 0·0013 grams of nitrogen from the air, of which a part was certainly ammonia.

The object of the researches of which a summary is given in the second paper was, to determine the quantity of nitrates contained, at a given moment, in one *hectare* of cultivated ground, one of meadow, one of the forest-soil, and in one *metre* of river or spring water. The quantity in the soil was of course found to vary extremely with the extremes of wet or dry weather. Garden soil, highly manured every autumn, contained on the 9th of August, 1856, after fourteen dry and warm days 316·5 grams of nitre in a cubic litre of soil. On the 29th of the month, after twenty rainy days, the same quantity of the same soil contained only 13 grams of nitre. The greater part had been dissolved out of the superficial soil.

Some specimens of forest-soil, in a state of nature, furnished no indication of nitrates: others gave 0·7 and 3·27 grams of nitre to the cubic metre.

The soil of meadows and pastures afforded from 1 to 11 grams of nitre to the cubic metre. Nineteen specimens of good cultivated land gave, four of them none; others from 0·8 to 1·33; the richer ones from 10·4 to 14·4, and one fallow, of exceptional richness, as much as 108 grams of nitre to the cubic metre. To the latter much calcareous matter had been added.

The soil of a conservatory, from which the nitrates would not be washed away by rains, contained 89, or 161, and some rather deep soil 185 grams of nitre in the cubic metre.

The sources of the nitre are not difficult to understand when we reflect that a manured soil, especially a calcareous one, is just in the condition of an artificial nitre-bed. The ultimate result of the decomposition of ordinary manure is a residuum of alkaline and earthy salts, phosphates, and nitrates, the latter, with the ammonia furnishing the assimilable nitrogen, all-essential to productive vegetation. In incorporating with the soil undecomposed manure, instead of the ultimate results of the decomposition, less loss is suffered from prolonged rains washing out the formed nitrates.

The soluble matters washed out of the soil are to be sought in the water. River and spring waters therefore act as manure by the silex and alkali, the organic matter, and the nitrates which they hold. The spring waters poorest in nitre of those examined contained from 0·03 to 0·14 milligrams of nitre to the *litre;* the richer ones from 11 to 14 grams in the cubic metre.

As to river-water; the Vesle in Champagne held 12 grams, the Seine at Paris 9 grams the cubic metre. These were the richest. The Seine at Paris carries on to the sea, in times of low water 58,000 kilograms, in times of high water 194,000 kilograms, of nitre every twenty-four hours. What enormous amounts of nitre must be carried into the sea by the Mississippi, the Amazon, and by every great continental river; and how active, beyond all ordinary conception, must the process of nitrification be over all the land; and how vast the supply of assimilable nitrogen for the use of the vegetation! A. G.

10. *Action of foreign Pollen upon the Fruit.*—In the last number of this Journal, p. 443, some facts were referred to which led to the supposition that pollen applied to the stigma may exert some specific action upon the ovary itself, independent of its action upon the ovules determining the

' the embryo. This was mentioned as furnishing the most e to the explanation of the reputed fact that squashes are is the quality and appearance of the fruit altered) by pump- ; in their vicinity, and *vice versa;* and even that melons are quashes; and this notwithstanding the fact, ascertained by distinct species of *Cucurbitaceæ* refuse to hybridize, although aces of the same species cross with the greatest facility. It is reed that the alteration of the character of the fruit is imme- hat it affects the ovary itself which has been contaminated ollen. It might then equally affect the fruit whether the ny of them fertilized or not; and in Naudin's experiments ion of pollen apparently caused the fruit to set, even when re fertilized.

nilar case of direct action of alien pollen upon the fruit, or s in Indian Corn, and is familiar to every farmer in the the form of grains of different varieties on the same ear. A nce is before us in a small ear of Sweet Corn, grown in the patch of the common hard yellow variety; in consequence six grains in every row have become yellow corn, while the he characteristic appearance of the sweet variety. It is not several sorts of maize are cultivated together, to find nearly eparately represented upon one ear. This must be the result, ss-fertilization of the previous year showing itself, not in a the characters of the fruit of the progeny, but in a complete to the constituent sorts in the fruit resulting from one seed, be a wonderful anomaly, but no impossibility; or else, of an ction of the pollen the present year, as is reputed of squashes

But the occurrence of three sorts of corn upon one ear ards excluding the first supposition, since there can have been ediate parents to one embryo. A. G.

ture and development of the Flower and Fruit of the Pear; NE. From a communication made to that active association, al Society of France,—of which an abstract is published in er's Chronicle of Nov. 14th, we learn that Decaisne has irect observation of the development, the correctness of that ing the structure of the pomaceous fruit which we have tained on general morphological grounds. The pips are the they are separate and free at their first appearance: a little th from the receptacle forms an open cup around them, ends ly investing them, and becomes the flesh of the core. In the base of the at first sessile flower-bud elongates into a pedun- er part of this thickens with the bud itself, and forms the er part of the pear, which therefore, below the carpels, is e stalk, as absolutely as in *Anacardium* or *Hovenia.* From ations and others upon *Melastomaceæ*, &c., Decaisne con- he orthodox view of the structure of the flower, "as explained rious masters, R. Brown, DeCandolle, and Jussieu" is demon- ct; that "it is not necessary to call into account that axis the present day so often and so willingly appealed to for ex- structure of flowers and fruits;" that "it is not impossible to

bring under the common law of organization the ovaries with a free central placenta, whose differences from ordinary ovaries are more apparent than real;" that most probably placentation always, in spite of appearances, belongs to the ovarian leaves. We are pleased to find that the experience of this eminent botanist has brought him into agreement, as regards the conception of species, with the views of those whom we must regard as the soundest workers and writers of the present day, and those on whom the hopes of the science rest. He states that if he had the *Plantagineæ* to elaborate anew, he should not hesitate to reduce considerably the number of species, "and perhaps to refer some entire sections to a single specific type." Perhaps even the greater part of two sections, we may add; for of two sections in the Prodromus, one is founded upon substerile and the other upon truly fertile forms of the same species, or set of species: and in another part of the genus one wide-spread American species figures under at least a dozen names. See notes on *Reports of Pacific Railroad Explorations*, vol. 4, p. 117.* A. G.

12. *Naturhistoriske Bidrag til en Belkrivelle af Grönland;* af J. Reinhardt, J. C. Schiödte, O. A. L. Mörch, C. F. Lütken, J. Lange, H. Rink. 8vo, pamph., pp. 172, with map. Copenhagen, 1857.—This work contains a complete catalogue of the fauna and flora of Greenland as far as known, together with some account of the geology and meteorology. It is a work of great importance to North American naturalists, relating as it does to our northern Fauna and Flora, and containing many valuable remarks upon the genera and species, particularly in regard to their synonymy. The zoological portion only will be noticed here. The Mammalia, of which there are 27 species, Birds, 111 species, Fishes, 69 species, Crustacea, 138 species, and Annelida, 87 species,—are elaborated by Reinhardt; the Insects by Schiödte; the Mollusca, 211 species, and Acalephæ, 33 species, by Mörch; the Echinodermata, 29 species, and Polypi, 7 species, by Lütken.

In the catalogue of testaceous molluscs, our conchologists will not be surprised to see many of our familiar species appearing under strange names. In this department of zoology, the names, particularly those of the genera, seem to undergo a periodical change. Of Pulmonates there are eleven species, seven land and four freshwater. *Vitrina angelicæ* hardly differs from *V. pellucida;* if distinct it is probably identical with *V. limpida*, Gould. The various divisions of *Helix*, as *Conulus*, *Helicella* and *Helicogena*, are adopted as genera.

Our *Bulla triticea* is regarded as the same as the European *Cylichna alba*. *B. Reinhardi*, Möll., is catalogued as "*Cyl. insculpta*, Totten," which however is only a synonym of *Bulla solitaria*, Say. *Dendronotus Reynoldsii*, Couth., is considered a distinct species from the European *arborescens*, to which it is generally referred by our naturalists. Four species of *Velutina* are mentioned, *V. flexilis*, *lanigera*, *haliotoides* and *zonata*. The classification adopted is singular in some respects; for example it is somewhat startling to see *Littorina* introduced between *Velutina* and *Natica;* while *Rissoa* and its allies are placed between *Natica* and *Cerithium*. *Natica* is divided into four genera, *Natica*, *Lunatia*, Gray,

* These volumes some of them contain much interesting botanical matter. We may call attention to them when the remaining volumes are published.

Mamma, Klein, and *Amauropsis*, nov. gen. Our *Natica clausa* is *N. affinis* (*Nerita*) Gmel. *N. grönlandica*, Beck., is a *Lunatia*. *N. immaculata*, Totten, is said to be the young of *N.* (*Mamma*) *borealis*, Gray, 1839; if so, Totten's name has priority. *Natica helicoides*, Johnst., is called *Amauropsis islandica* (*Nerita*), Gmel. *Adeorbis costulata* is placed in *Cyclostrema*, Marryat. *Mangelia turricula* of our coast is regarded as distinct from the European *Fusus turriculus* and styled *Defrancia scalaris*, Möll. The name *Tritonium* is adopted for *Buccinum*, including *B. glaciale*, *Donovani*, *undatum*, *grönlandicum*, *Hancockii*, *tenue*, *undulatum*, *Humphreysianum*, and *ciliatum*; while the name *Fusus* is retained for *F. despectus*, *tornatus*, *islandicus*, *norvegicus*, etc. The rules of nomenclature would however seem to require that *Buccinum* should be retained, being the older name, whether *Tritonium* be preferred to *Fusus* or not. *Fusus clathratus* is placed under *Murex*. *Spirialis Gouldii*, Stimpson, is correctly referred to *Limacina balea*; but we cannot see why the name *Heterofusus* of Fleming, founded on an error, should be preferred to the more euphonic one of Souleyet. *Margarita undulata* is *M. grönlandica*, Chemn., 1781. The names *M. cinerea* and *argentata* of our naturalists are acknowledged over European synonyms.

Patella candida is regarded as identical with *P. cæca* and arranged in *Lapeta*, Gray (*Cryptobranchia*, Midd.). *Cemoria*, Leach, is retained over *Diadora*, Gray. Only two Chitons, *C. marmoreus* and *C. albus*, are catalogued, and the subgenera of Gray are adopted. Eight species of Cephalopoda are found in the list, which seems a large number in view of the fact that only three are known to occur on the eastern coast of the United States. The Greenland *Teredo* is set down as "*T. denticulata*, Gray, 1850," with *T. dilatata*, Stimpson, as synonym; an error of date, the latter name having been published, with description, in Oct. 1851; Gray's name in the Ann. and Mag. Nat. Hist. for Nov. 1851, with no description. *Cyrtodaria* of Daudin is retained for *Glycymeris*, Lamk. *Tellina proxima* is *T.* (*Macoma*) *sabulosa*, Spengler, according to Mörch. We are not aware however of its having been called *Psammobia sordida* either by Couthouy or Gould. *Tellina fusca* (*grönlandica*, Beck) occurs under the name of *T. tenera*, Leach, in Rozet's Journal, 1818. Should this name hold, our common species *T. tenera*, Say, 1821, must receive a new designation, and might be called *T. agilis* in view of its quick and sprightly movements. *Serripes*, Beck, is preferred to *Aphrodita*, Lea; which latter name however has priority, and should stand unless rejected on account of its occurrence in other departments of the animal kingdom. *Nuculana*, Link, is retained over *Leda*, Schum.

Several of our New England mollusks, whose limits were not before known to extend so far north, are mentioned in the catalogue: as *Bulla insculpta*, *Eolis Bostoniensis*, *E. salmonacea*, *Rissoa eburnea*, *Thracia truncata*, *Montacuta elevata* and *Kellia planulata*. Many other points of interest to our malacologists may be found in the catalogue, but our space will not permit of further notice of them here.

We will add a few brief remarks upon Lütken's catalogue of the Echinodermata. Of this class we find 9 Holothuridæ, 1 Echinus, 8 Asteriadæ, and 11 Ophiuridæ. *Cucumaria* is retained instead of *Pentacta*, Goldfuss, notwithstanding the latter has priority. *C. Koreni*, Ltk., nov. sp., is

Pentacta calcigera, St., Bost. Proc., 1851. *Cuvieria* is united to *Psolus* and with good reason. The new genus *Eupyrgus* seems related to *Psolus; Myriotrochus* of Steenstrup to *Chirodota*. *Asteracanthion grönlandicus*, Stp., scarcely differs from *A. littoralis*, Stimpson, Synopsis Inv. of Grand Manan, p. 14, while *A. problema*, nov. sp., is identical with *A. albulus*, St., loc. cit. *Ophiura Sarsii*, Ltk., n. s., is common on our coast and here considered a variety of *O. ciliata*. *O. squamosa*, Ltk., nov. sp., is common at Grand Manan, and is *O. robusta* of the Synopsis. *O. robusta* of Ayres seems to include both *O. squamosa* and *nodosa* of Lütken. It is proper to state that the above identifications are established upon actual comparisons of specimens. W. S.

13. *Contributions to The Natural History of the United States of America;* by LOUIS AGASSIZ. First Monograph in three parts: I. Essay on Classification; II. North American Testudinata; III. Embryology of the Turtle. In two volumes 4to of 640 pages, with thirty-four plates. 1857. Boston: Little, Brown & Company. London: Trübner & Co. Subscription price, per volume, $12.

These two quarto volumes on American Zoology are the first of a series of ten volumes, which Prof. Agassiz has in course of preparation. It is most honorable to the country and a high tribute to the author, that this great work is appearing under so liberal auspices.

Eleven years ago Prof. Agassiz landed in America: since then his labors have been incessant, and as a consequence, a large amount of drawings and manuscripts connected with American zoology had accumulated on his hands. The seashores here opened to him a field in zoology he had not hitherto enjoyed, the rivers and lakes were full of life that had new revelations for him, the whole land in every direction tempted a mind in love with all forms of nature, and nearly every department of zoology had therefore been the subject of special researches. Encouraged and aided by a distinguished friend, Mr. Francis C. Gray of Boston—since deceased—the plan of publication by subscription was set on foot. Prof. Agassiz alluding to his benefactor and the subscription, says, in his Preface:

"He took the whole direction himself, awakening attention to it by personal application to his friends and acquaintances, by his own liberal subscription, by letters, by articles in the journals, and by every means which the warmest friendship and the most genuine interest in science could suggest. He was rewarded beyond his utmost hope or mine, by the generous response of the public to whom he appealed. We had fixed upon five hundred subscribers as the number necessary, to enter upon the publication with safety; and we had hoped that the list might perhaps be increased to seven or eight hundred. At this moment it stands at twenty-five hundred: a support such as was never before offered to any scientific man for purely scientific ends, without any reference to government objects or direct practical aims,—although I believe no scientific investigations, however abstruse, are without practical results. My generous friend did not live to witness the completion of the first volume of the series, which without his assistance could not have appeared, but he followed with the deepest interest every step in its progress, to the day of his death;—he did live, however, to hear the echo which answered his appeal to the nation, in whose love of culture and liberality towards all

intellectual objects he had felt so much confidence. From all the principal cities, and from towns and villages in the West, which a few years since did not exist; from California, from every corner of the United States,—came not only names, but proffers of assistance in the way of collections, and information respecting the distribution and habits of animals, which have been of the utmost assistance in the progress of the work."

Prof. Agassiz, from his first arrival, has identified himself with American science. He left Europe behind him, and cared not even to seek European channels for his publications, although they have the advantage of wider circulation and repute. He has often spoken with strong disapprobation of that petty ambition sometimes seen on this side of the waters, to contribute to a foreign periodical, rather than those of the land. His lot and mission were here; and the response he has met with from the country is testimony, not simply to his science, but to the noble feelings of the man. On certain of his views men may differ; but as to honest purpose in research, thoroughness of investigation, breadth of philosophical ideas, and beauty of actual results, there can be but one opinion.

The work as projected, was to consist of ten volumes of about 300 quarto pages and twenty plates each. The subject intended for the first volume expanded under the hands of the author through the extension of his researches, and also still more from the introduction of a series of chapters on the philosophy of classification and a kindred topic of general interest growing out of it—Creation the work not of physical agencies, but of a personal Creator. The text was thus enlarged to the size of two volumes and the plates also were increased in number to nearly double that projected. The publishers have therefore issued the whole in two volumes. Prof. Agassiz states in his Preface that in the third volume, which is already far advanced, the deficiency in the number of plates will be fully made up, the subject requiring very numerous illustrations.

Prof. Agassiz, besides his many acknowledgements of aid received in the way of specimens and information, mentions Mr. James E. Mills and Mr. H. James Clark as valuable assistants in his scientific researches, the latter especially in microscopic dissections and drawings. He gives high commendation to Mr. A. Sonrel, the artist, whose labors as draftsman have contributed to his works now for twenty years. The beauty and finish of the plates fully justify the remark respecting Mr. Sonrel in the preface—"The mastery he has attained in this department, and the elegance and accuracy of his lithographic representations, are unsurpassed, if they are anywhere equalled."

As we shall return to these volumes again, we here give only a list of the topics of which they treat.

Vol. I, Part I. *Essay on Classification.*

Chapter I. The fundamental relations of animals to one another and to the world in which they live, as the basis of the natural system of animals: under which head, the author treats of—the actual foundation in nature of the true zoological system or classification,—the unity of plan throughout the diversified types—the distribution of the same types over widely diverse geographical regions, and as widely diverse geological ages,—the permanency of types and the immutability of species,—the relations between plants and animals and the surrounding world,—em-

bryology a basis for determining the rank of species—succession in geological time a basis for deciding approximately upon rank;—all of which topics, besides others not here enumerated, are so handled as to bear directly on the question of creation by physical agencies, giving it a decided negative reply.

Chapter II. Leading groups of the existing systems of animals—a philosophical disquisition on the true significance of the grades of subdivisions in the kingdoms of life, the nature of species, genera, families, orders and classes.

Chapter III. Notice of the principal systems of zoology, including observations on the systems of Aristotle and Linnæus; the *anatomical* systems of Cuvier, Lamarck, Ehrenberg, Burmeister, Owen, von Siebold and others; the *physio-philosophical* systems of Oken and McLeay; and the *embryological* systems of Döllinger, von Baer, Vogt, etc.

PART II. *North American Testudinata.*

Chapter I. The Order of Testudinata, its rank, classification, general characters, anatomical structure, geographical distribution, geological history, etc.

Chapter II. The Families of Testudinata.

Chapter III. North American genera and species of Testudinata—their characters, distribution, etc., for the several families.

PART III. *Embryology of the Turtle.*

Chapter I. Development of the egg from its first appearance to the formation of the embryo.

Chapter II. Development of the embryo from the time the egg leaves the ovary to that of the hatching of the young, including the laying of the eggs,—the deposition of the albumen and formation of the shell, —the absorption of albumen into the yolk sac,—the transformations of the yolk in the fecundated egg,—segmentation of the yolk,—the whole egg is the embryo,—foldings of the embryonic disc and successive stages of growth of the Turtle,—formation and development of the organs,—histology,—chronology of the development of the embryo.

The young of various species and the several successive phases in embryological development are illustrated with details in the plates, all of which are crowded full of figures.

In another number, we propose to give an abstract of some of the views brought forward in these volumes.

IV. ASTRONOMY.

1. *New Asteroids.*—The number of small planets already discovered between Mars and Jupiter is *fifty.*

The 46th was discovered by Mr. Norman Pogson, Oxford, Eng., Aug. 14, 1857;—the 47th (of 11th magnitude,) by Dr. R. Luther, Bilk, Sept. 15, 1857;—the 48th (11th magn.) and 49th (10th magn.) by Mr. H. Goldschmidt, Paris, Sept. 19 and 22, 1857;—the 50th (Virginia,) of 11th magnitude, by Mr. James Ferguson, Washington, D. C., Oct. 4, 1857.

2. *New Comets.*—The Fifth comet of 1857 was discovered by Mr. Klinkerfues, Göttingen, Aug. 20, 1857. In September this comet became visible to the naked eye, and had a tail about 3° in length.

The Sixth comet of 1857 was discovered by Mr. Robert Van Arsdale, Newark, N. J., Nov. 10, 1857. It appeared like a faint nebula.

ble Stars discovered by Mr. Alvan Clark, Boston, U. S.; Remarks, by the Rev. W. R. Dawes. (From the Proceed-
ral Astronomical Society of London, Vol. xvii, No. 9).

ıation.	R. A.	N. P. D.	Mag.	Approx. Dist.	Tel. of Discovery.	Date of Discovery.
	h m	° ′		″	Inch.	
e..........	0 13·5	57 49	7, 7	0·4	7⅜	Oct. 1856.
....	3 10·7	91 29	5½, 10	0·8	7½	20 Dec. 1853.
sel, vi, 109..	6 4·3	94 38	6½, 9	1·1	7¼	6 Feb. 1854.
sel, vi, 1291.	6 42·2	104 59	6, 9	1·0	4¾	17 Feb. 1852.
....	9 45·1	97 24	6, 6½	0·6	4¾	7 April, 1852.
....	12 0·3	109 32	6		4¾	19 May, 1852.
. & C.	17 40·6	62 11	10½, 11	1·8	7¾	July, 1856.
....	17 47·4	60 17	8¾	0·3	7¾	July, 1856.
....	17 48·7	60 9	10, 10½	1·1	7¾	July, 1856.
....	18 16·4	110 37	5, 8	2·5		
sel, xviii, 391	18 17·2	91 39	7, 7½	0·5	7¼	30 July, 1854.
sel, xix, 1273	19 50·6	92 38	7½, 8	0·9	7¼	18 July, 1854.

of these difficult objects have been from time to time to me in letters from their discoverer, who has adopted :ing the efficiency of his object-glasses when completed by 'w double stars of the last degree of difficulty, rather than ation of objects whose character was previously known. the impression that every such object in the northern ible with telescopes of moderate aperture must already :ed up and registered during the careful examinations of the heavens by the Struves with the Dorpat refractor of ture, and with the Poulkova of 15, Mr. Clark confined his southern hemisphere; and his diligence and skill were e discovery of several interesting objects, which, it might ould hardly have escaped the Dorpat telescope if they had dly double in 1826 as they are now. Latterly, however, d to extend his researches northward, he has made some ch are almost startling (especially the duplicity of the very ıion of *μ Herculis*), and are sufficient to show that there is ay be achieved by a diligent use of instruments of modes, provided they are also of extreme perfection. A few of the most interesting of these objects may not, perhaps, e.

r has a good altitude at Poulkova, and its magnitude enlace in Otto Struve's catalogue. Its omission there may to a suspicion that it has a binary character, and has of e out from a state of apparent singularity. I have ob- oximate measure of this star, but have not examined it ly favorable circumstances.

Ceti I have repeatedly obtained measures; but it is a delid from its moderate altitude here requires fine circumsmall companion, which has a purplish tint, is faint and therefore, have easily escaped detection at Dorpat.

standing the moderate meridional altitude of 8 *Sextantis* ut 24°), it may reasonably be doubted whether its duplicity

would have been left to be discovered with a $4\frac{3}{4}$-inch object-glass, however perfect, if no change had occurred in its appearance since Struve's scrutiny of that part of the heavens.

"7. The position and distance of the small star with respect to *μ Herculis* were observed by Struve at Dorpat on one night in 1829, on two nights in 1832, and on three in 1836; and also on one night at Poulkova with the 15-inch refractor in 1851. Yet no suspicion was recorded on any occasion of the companion being double. It is, therefore truly astonishing that Mr. Alvan Clark should have detected its unsuspected duplicity with an object-glass whose aperture is only $7\frac{3}{4}$-inches! I have succeeded in measuring it pretty well in position, but only approximately in distance; the faintness of the components almost forbidding the slightest illumination, though they bear a high power on Clark's 8-inch object-glass,—about 700 suiting them best. My results are P$=58°\cdot97$; D$=1''\cdot85\pm$. It has been shown by Struve (*Pos. Mediæ*, p. ccxvii,) that μ and its companion have a common proper motion; so that in this respect they are similar to μ and μ^2 *Boötis*; and as the companion of *μ Herculis* has now been discovered to be *double*, it only remains that it should prove to be *binary* to render the resemblance complete. It is, therefore, earnestly commended to the attention of those observers who possess telescopes competent to deal with it. As the small star *precedes* the large one, the former is properly μ^1, and the latter, μ^2, if that nomenclature be adopted.

"8. This star is about as difficult as the closest of the Poulkova catalogue; and though on a fine night elongated with the 8-inch object-glass I now have in use, would require the full power of a 15-inch refractor fairly to divide it. That it attracted Mr. Clark's attention as a double star is sufficient to prove that his eye as well as his telescope must possess extraordinary power of definition.

"9. This double star forms a good introduction to the small one of *μ Herculis*; its components being brighter by about half a magnitude of my scale. With my 8-inch object-glass and power 697, I have obtained, P$=229°\cdot48$; D$=1''\cdot119$.

"11. A very difficult object, though decidedly elongated with a $7\frac{1}{4}$-inch aperture. My measures in 1854 gave, P$=178°\cdot10$; D$=0''\cdot425$, the latter a mean of two estimations.

"12. A neat and not very difficult object; it ought certainly to have been seen at Dorpat if it were as separate then as it is now. My measurements with Clark's $7\frac{1}{4}$-inch object-glass gave in 1854, P$=323°\cdot76$; D$=0''\cdot863$."

"Haddenham, Thame, July 9, 1857."

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Prof. Richard Owen of Nashville, Tennessee, on the Outlines of the Continents.*—In noticing in our last number the communication of Prof. Peirce on the tangency of the great circles in which the coast lines lie with the Arctic and Antarctic circles, we stated the fact that the same view had been brought out in a work published by Prof. Owen, but by mistake made the publication of Prof. Owen's work subsequent in date to the first announcement of Prof. Peirce's views. A communication from Prof. Owen makes it clear that his publication has the priority, by

› or three months. His account is explicit. As some general interest ıttached to these views, whatever their bearing or geological import- ›e, we cite a few paragraphs from Prof. Owen's work. Aiming to ng out the "fixed rules" in the earth's structure he says; p. 36—

'The first step, in accordance with the above plan, is to collect the ts regarding the *Direction of the Coasts*, in their great outlines; also the mountain ranges, rivers, etc.

'Here we at once perceive, if we elevate the north pole of the globe ½° above the horizon, that, when we revolve the globe, we bring many the great continental coasts, as well as shorter gulf and island coasts, cessively to the horizon, proving their parallelism: for instance, the st of North America, (California,) part of the western coast of South- ı Africa, (coast of Guinea), west coast of Arabia, India, Birmah, Malaya, matra, Corea, Australia, and Borneo.

'Now depress the north pole 23½° below the horizon, and you bring ı *eastern* coast of North America, (Atlantic seaboard of the United ıtes,) the *east* coast of Southern Africa, and the general trend of the tern Asiatic coast, (between Behring's Straits and the Gulf of Siam,) cessively parallel to the horizon.

"A third set of coasts will be found parallel to the horizon, when we vate the *equator* 23½°; in which case the west coast of Central Amer- , the Northern coast of South America, the general direction of the diterranean coasts running from east to west, will be included in the mber, and will be observed to be chiefly intertropical; while those pre- ›usly pointed out are, for the most part, between the equator and the :tic circle or the equator and antarctic circle."

The origin of this system of lines is attributed to "solar influence in ne of its modifications."

Prof. Owen also brings in 23½° as a distance, making what appears to a fanciful or unmeaning use of it. He observes, p. 44,

"Not to weary the reader with similar details, which he can multiply lefinitely at his pleasure, it will suffice to enumerate a few prominent tances spanned by 23½°, and several smaller measurements which seem be the eighth part of 66½°, or nearly 8¼°; near enough at least for ıctical purposes.

"The former of the two measurements, viz., 23½°, will be found to be : distance from the Alps to Palestine, as well as, in a due south direc- n, to the Tropic of Cancer; also from the Alps successively to the ıdeira Islands, to Mount Hecla in Iceland, to near the Malström, to ke Onega, and to the eastern shore of the Black Sea.

"It also measures from Palestine to the Baltic, to the Sea of Aral, to : south coast of Arabia, and to the Gulf of Genoa, and indicates the ıtance from Africa to the nearest point in South America.

"The smaller measure (about 8¼°) will be found to reach from the rth of Scotland to the British Channel; from the west of Ireland to ınders; from the west of Scotland to Denmark; from the Malström to : Baltic; from the Baltic to the Adriatic; from Calais to Genoa; from est to Marseilles; from Cape Finisterre to Cape St. Martin in Spain; ›m Genoa to Etna; from Tunis (ancient Carthage) to Barca; and from : Alps to the Gulf of Tarento," etc.

As we have expressed our dissent from the general principles of the work, we cite further a few paragraphs in order to give more definiteness to our objection, and at the same time to show those who may be interested, the nature of some of the discussions in the volume.

The subjects of the chapters of the work are—1. Physical, Statical or Geographical Geology; 2. Dynamical; 3. Anatomical; 4. Botanical; 5. Zoological; 6. Anthropological and Ethnological; 7. Pathological and Therapeutical; and last (8.) Ethical Geology.

Almost immediately following the last citation, in the 2nd chapter, he states, and afterwards discusses this announcement, p. 45:

"*The different successive geological periods will be found more recent, and less dense in structure, as they leave the north pole and approach the equator.* Although certain layers probably invest the globe, in a succession never inverted, yet, where upheaved, the edges or vertical sections of these formations appear to have been brought to the surface along concentric (or subconcentric) lines, which are parts of great circles, intersecting each other in such a manner as to form equilateral spherical triangles on the earth's surface: each angle of intersection being equidistant from our present north pole; also in such a manner as to cause hypozoic outcroppings in the smaller triangles, palæozoic in the next, and cainozoic in the larger."

On the next page occurs the following strange paragraph:

"By carefully laying down, on accurate maps, all the prominent points at which the Hypogene rocks are found in close proximity to Secondary rocks, and the latter again to Tertiary rocks, rejecting a few anomalies which occur chiefly at or near the above described longitudinal lines of upheaval; by carefully noting the chief localities in which coal and the ordinary metals have been found, there seems no doubt that these geological lines of junction and of greatest metalliferous surface-wealth, form as already stated, equilateral spherical triangles, the three sides of each of which are formed by the intersection of great circles, and the apex of which is to be found very nearly if not quite at the terrestrial North Pole; it is consequently probably the apex of a nucleiform spherical tetrahedron, on the curved faces of which there appear to have accumulated successive layers of deposition. However, whatever the theory may be, the practical result is, that by following the lines indicated on the map we connect nearly all the points at which mineral wealth has thus far been found, and in which ranges therefore we may most reasonably expect again to find it, at intermediate points or on extensions of those lines."

Chapter III. is devoted to "Anatomical and Physiological or Stratigraphical Geology—an attempt to demonstrate the analogy between organic structures and geological strata;" and after discussing the general nature of organic structures, the author draws out the analogy in the following geological extravaganza (pp. 84–88):—

"Our planet, perhaps, typifies an ovule from the solar matrix: in its earlier igneous, chaotic state, it bore analogy to the yet undeveloped amorphous structure of vegetable ovules and the animal ovum. Like them it had at an early period a nucleus, on which, after a time, air and moisture deposited additional materials, derived from the matrix. At a yet later period, a part of these same materials were carried in mechani-

mixture, partly in chemical solution, to promote the development of r formations, forming new continents, etc.; just as a portion of the l (the albumen) and the food-yolk of the egg go to nourish the ex-ding germ.

'The separation of continents typifies the propagation by off-shoots, rtificially by cuttings, in plants; and seems to resemble the fissiparous de of reproduction observed among the lowest animals. In some of earlier cataclysms, we have the type of the ruptured Graafian vesicles, ile at a final convulsive deluge, the period when the Western Conti-t and Australia were detached, and when possibly the moon, as a ter-rial ovule, was thrown into space, we readily recognize the type of tured pericarpal dissemination of seed, in the vegetable world, of com-ed incubation and parturition in the animal kingdom.

'But the analogy may be carried much farther: the earth, like man, its mountain masses giving stability to the length and sometimes the adth of the land, just as the skeleton forms the framework of attach-nt for muscles, etc. The materials solidified at the earliest periods are stalline, depositing materials around central points, as the earliest es, those of the head, commence their ossification by the arrangement cells around a centre, or as the earliest animals partake of the radial e. At a later period the same materials (the serous layer of the germ-k in the animal, the detritus of igneous materials in the mineral rld) furnish an ample deposit, which, in the long bones of the limbs, nur and humerus,) in the muscles, etc., now partake of a lamellar ap-rance, the result of cells arranged in layers, viewed in their vertical tions. On the earth's crust, these deposits are carried by aqueous ac-n from the high and hard mountains, and are afterwards consolidated, heat, pressure, and electrical forces, into the sedimentary rocks of the ious later periods.

'When an abundant supply of carbon has been furnished for the wth and subsequent decay of vegetation on the earth's surface, we n have the type of an extra-uterine nourishment.

'We have the coal period forming its vast layers of carbonaceous de-its, which, by slow chemical action under a portion of the earth's st, the evolution of various gases, and the formation of new compounds, in keeping up the temperature of the internal earth. The water, kling through the earth's pores, dissolving and carrying many saline l other ingredients to the ocean, is the type of the early lacteal pro-cts in the animal mingling with the venous blood, to be carried to the at centre of circulation, the heart, as the small streams unite into ge, and carry the dissolved materials to the great deltas, and finally o the ocean gulfs.

'Turning our attention first to the Western Continent, we find, as just ted, the smaller streams anastomosing, (as the veins do to form the a cava,) and at last discharging the chief waters of North America, the Mississippi, into the Gulf of Mexico; while the Orinoco, Amazon, l Rio de la Plata send the inosculated waters of South America also ard the same gulf, through the currents tending to the Caribbean Sea.

'Here we have the type of that venous or vitiated blood, which is now own into the great central heart, and thence propelled, in the Gulf-

Stream, chiefly north and east, toward those regions where the ocean is less salt, as the Baltic; entering also the Mediterranean, and leaving there large saline deposits, the water of the ocean is evaporated by the heat of the sun, increased in intensity by reflection from Africa's sandy Sahara; and, thus purified, the aqueous vapor mingles with the atmosphere, to be carried along by its currents, until the accumulated humid contents of a cloud (typifying arterial circulation) descend, when its temperature has been depressed to the dew-point, as a pure deposition of aerated water, upon the thirsty earth, and filter through the loose soil, to carry nourishment to that earth, its plants and animals, and again perform the same circulating course of evaporation, purification, and condensation.

"The atmosphere, then, besides forming the type of aerial communication between parent and offspring, as indicated in the tabular view, is the type too of the great aerating organ, the lung, (whether under the form of external branchial tufts or internal parenchymatous structure, forming pulmonic sacs.)

"If the above be true, I would ask the scientific man not to sneer, when I hesitatingly inquire, whether it is possible that in the Western Continent we have the male type, of greater length with less breadth, even the type of the air-breathing animal, with its vast central air-caverns; and whether, at a former period, it foreshadowed the usual fœtal curvature *in utero*, before extension; whether in the Eastern Continent we have the maternal type, the cretaceous period corresponding to that of lactation, the greatest pelvic width typified in the highest Himalayas, and the water-breathing type with its central intercommunicating whirlpools?

"Well aware of the ridicule to which I expose myself, and feeling keenly the criticism of those competent to decide, I yet am impelled by a sense of duty to ask these questions, not as mere matters of speculative interest, but as queries, the answers to which may lead to important practical hygienic results, such as it will be attempted more especially to develop in some of the remaining chapters.

"Should the *probability* of any of the above analogies be admitted, Australia at once establishes its claim to the placental type, as well as on account of its former position, and the great evidences that the upper layers have been torn away, leaving an arid country around the Dead Sea some thirteen hundred feet below the level of the Mediterranean; as also by the marked peculiarities of its flora, (for instance, its leafless acacias, the petioles of which retain the nourishment that they should transmit to the leaves,) and of its noted fauna, among which so many belong to the order Marsupialia, exhibiting a tendency to an extra-uterine pouch or enormous development of the nipple integument, while other animals of that anomalous continent, and its detached New Zealand, form the link between the oviparous bird and viviparous mammalia, the Monotremata.

"In the attraction exerted by the moon over the tides, we have the type of the periodicity, to be enlarged upon more in the Chapter on Pathological variations; and it may suffice now to ask again, whether we have not, in the periodical flux and reflux, the type of normal and ab-

normal, regularly recurring exacerbations, as in intermittent and remittent fevers, in the periodical excretions, alvine, urinary, etc., in the catamenia, and even in the arrival and departure of epidemic agency?

"To recapitulate, in a more connected form, this comparison of inorganic with organic phenomena, we observe that the older rocks (the Hypogene, crystalline, non-fossiliferous) are chiefly found in the arctic and antarctic regions, (although, also, more or less accompanying every period;) next to those come the Secondary, (Palæozoic and Mesozoic rocks,) chiefly in the north temperate zone; while nearer the tropics are chiefly developed the Tertiary and newer formations. The Hypogene rocks, being of all ages and forming the hardest and highest mountain ranges, as well as in other particulars to be pointed out below, resemble the serous layer, which forms the great framework and consolidates at different periods of life. The Secondary formation resembles the vascular layer; and the Tertiary is the analogue of the mucous layer, although in the animal it is more frequently an internal than an external layer."

Remarks on these passages are unnecessary.

2. *On the Supposed Meteorite from Marblehead;* by A. A. Hayes.—A part of the mass of this substance, which was first described in a Salem paper a few days since, having been sent to me for chemical analysis, it has proved to be *an artificial product of the arts.*

The piece examined was externally black; its surface was channeled owing to numerous semicylindrical elevations, produced by the flow of jets of fluid mineral matter. Internally the color was blackish grey, the compact parts being crystalline; while numerous elongated and spherical bubble cavities rendered other parts porous and uneven. Much of the recent as well as the exposed part of the fracture exhibited a pseudo-metallic lustre of the color of copper, which also appeared in the cavities. A part of the exposed surface was coated by a light yellow ochry covering, easily removed from the black glazed surface below. When fractured, the glazed surfaces of the small streams of once-fluid matter were found in every part of the specimen, showing that the structure was made up by the material being successively added on previously cooled parts in jets or small streams.

When subjected to chemical tests, iron in a metallic state was found; its composition was that of cast iron containing carbon, without any trace of nickel. The other constituents were in an oxydized state, excepting a minute portion of sulphur compound, while traces of copper were found in every part of the substance.

It was composed of silica, proto-peroxyd of iron, lime, alumina, magnesia, sulphur, copper, which are the bodies present in the slags of copper furnaces. Like those slags, the specimen examined was readily decomposed by acids, in which the bases dissolve with a portion of silicic acid; *no natural minerals remain.* The composition of this compound, the presence of crude iron with its carbon constituent, and its mechanical structure, offer positive evidence of its being of artificial origin.

In the absence of nickeliferous or chromiferous iron, simple minerals of the magnesian class, and a natural internal structure, we have the negative evidence. Both leave no doubt that this body is a furnace product formed in smelting copper ores, or iron ores containing copper.

3. *On the Volcano of Kilauea, Hawaii;* by the Rev. TITUS COAN. (From a letter to J. D. DANA, dated Hilo, Sept. 1, 1857.)—I was at Kilauea with the younger Binghams and others in June last. Pele was rather quiet. The latest change is the subsidence of the vast dome, some 300 feet high and two miles in circuit, which covered the area of the ancient fire-lake, Halemaumau. All that area is now a deep basin, encircled by a rim consisting, in some places, of a bold perpendicular precipice, and in others of an inclined plane of unequal angles, rent into numerous yawning fissures and strewed with immense masses of debris. The bottom of this basin is rent and smoking, and studded with a few cones. Near the centre, and enclosed by a jagged rim from 20 to 50 feet high, is the lake of fire, which has burnt from time immemorial. It is about 100 feet below the rim and some 500 feet in diameter. When our party approached it, there was very little action; but in about half an hour, mother Pele, as if to give us a special benefit, began to fire up in earnest; the great cauldron boiling furiously on the southern side; the glaring fusion rolled in a fiery wave over the black and hardened crust which covered the lake like ice, breaking it down by sections, and tilting it at an angle of 30°, carried it under the burning flood, until the whole surface of the lake was aglare and all boiling together with vehement heat. This whole process did not occupy more than three minutes. Not a square inch of hardened crust remained. All was glaring fusion; and so intense was the radiating heat, that our whole party were driven precipitately back from our point of observation on the windward or northeastern bank, and more than 100 feet above the lake. No person could have approached the southern bank. After a little season, all was quiet again and the surface of the lake blackened and crusted over; Pele had dropped her curtain. These scenes were repeated in the night, as we could see from the great brilliancy occasionally displayed.

Mr. Coan, in the same letter, states it as his opinion based on his survey of the region, that the lavas of the last summit eruption of Mount Loa, which began in 1855, and continued on for fifty miles, all flowed from a *single* opening,—that of the first great outbreak.

4. *Earthquakes.*—About four o'clock on the morning of October 8, a shock of an earthquake at St. Louis, Missouri, "made the more substantial buildings tremble." Seven minutes later there was another shock. These shocks were felt at Springfield, Illinois, and elsewhere. At Centralia, Illinois, there were three distinct shocks at intervals of five minutes, at about the same hour in the morning, the first of the three being powerful enough to throw down chimneys.

On the 23d of October, soon after three o'clock in the afternoon, an earthquake shock was felt at Buffalo, N. Y. It was also perceived to the westward in Ohio, at Dayton, Forestville, etc.

Another shock occurred at Charleston, S. Carolina, on the morning of the 19th of December, about nine o'clock.

It is much to be desired that some person in the region of these earthquakes should collect all the information respecting them, especially with reference to the time and intensities of the shocks at different places,—these times accurately determined, being the data necessary for deducing the direction from which the earthquake came, its course, breadth, and progress, and the intensities, giving the point of greatest action.

5. *Tables of the Division of Mankind into Races, Branches, Families and Nations, with an approximative statement of the Population;* by M. D'OMALIUS D'HALLOY, (Bull. de l'Acad. Roy. Belgique, tome xxiii, 1856, p. 812.)

I. *Division into Races and Branches.*

WHITE RACE.—	European branch,	289,586,000	
	Aramean "	50,390,000	
	Scythian "	30,747,000	= 370,723,000
YELLOW RACE.–	Hyperborean branch,	160,000	
	Mongolian "	7,000,000	
	Sinic "	338,300,000	= 345,460,000
BROWN RACE.—	Hindoo branch,	171,100,000	
	Ethiopian "	8,300,000	
	Malay "	25,600,000	= 205,000,000
RED RACE.——	Southern "	9,200,000	
	Northern "	400,000	= 9,600,000
BLACK RACE.—	Western "	56,000,000	
	Eastern "	1,000,000	= 57,000,000
HYBRIDS, Mulattos, Zambos, &c.			12,217,000
		Total,	1,000,000,000

II. *Subdivision of the* WHITE RACE *into Families and Nations.*

1. *European Branch.*

TEUTONIC FAMILY.		
Germans, including the Dutch,	54,000,000	
Scandinavians.—Swedes,	3,634,000	
Norwegians,	1,563,000	
Danes,	1,709,000	
English, including the Scotch,	38,014,000	= 98,920,000
CELTIC FAMILY.		
Cymry.—Welsh,	650,000	
Bretons,	1,000,000	
Gaels.—Irish,	9,600,000	
Highlanders,	500,000	= 11,750,000
LATIN FAMILY.		
French,	39,900,000	
Spaniards, including the Portuguese,	22,865,000	
Italians,	26,160,000	
Wallacks,	7,095,000	= 96,020,000
GREEK FAMILY.		
Greeks,	2,990,000	
Albanians,	1,480,000	= 4,470,000
SLAVIC FAMILY.		
Russians, including the Rusniaks and Cossacks,	49,874,000	
Bulgarians,	3,387,000	
Servians,	5,500,000	
Slovenians,	1,306 000	
Wends,	142,000	
Chechs.—Bohemians,	3,144,000	
Moravians,	1,000,000	
Hanaks,	280,000	
Slovaks,	2,400,000	
Poles,	9,304,000	
Lithuanians.—Lithuanians, properly,	1,217,000	
Lettish,	872,000	= 78,426,000
Total,		289,586,000

2. *Aramean Branch.*

Basque Family.			
Basques,			775,000
Lybian Family.			
Berbers.—Amazirghs,		4,700,000	
Kabyles,		1,500,000	
Tuarics,		300,000	
Egyptians.—Copts,		150,000	
Fellahs,		1,500,000 =	8,150,000
Semitic Family.			
Arabs,		14,650,000	
Jews,		4,074,000	
Syrians,		500,000	
Maltese,		106,000 =	19,330,000
Persian Family.			
Tajiks,		8,775,000	
Afghans.—Afghans, properly,		3,500,000	
Belouchis,		1,500,000	
Patans,		5,000,000	
Kurds, including the Lures,		1,500,000	
Armenians,		1,228,000	
Ossetians,		32,000	
Georgians, including the Mingrelians and Lazians,		600,000 =	22,135,000
Total,			50,390,000

3. *Scythian Branch.*

Circassian Family.			
Cherkessians,		800,000	
Chetchents,		200,000	
Lesghians,		500,000 =	1,500,000
Magyar Family.			
Magyars,			5,000,000
Turkish Family.			
Osmanli,		9,500,000	
Turcomans,		1,500,000	
Tarekamehs,		1,000,000	
Nogai,		1,470,000	
Kirgis,		1,000,000	
Usbeks,		5,500,000	
Alatys,		30,000 =	20,000,000
Finnish Family.			
Finns of Siberia.			
Teleouts,	1,000		
Sagais; Kachints, etc.	20,000		
Woguls,	12,000		
Ostiaks,	103,000 =	136,000	
Finns of Eastern Russia.			
Bashkirs,	392,000		
Teptiairs,	104,000		
Metcheriaks,	80,000		
Chouvaschs,	430,000		
Cheremisses,	165,000		
Morduins,	480,000		
Permiaks,	52,000		
Sirijänes,	71,000		
Votiaks,	191,000	1,965,000	
Finns of the Baltic.			
Livonians,	2,000		
Esthonians,	654,000		
Kyrials; Ymes; Quaines,	1,490,000	2,146,000 =	4,247,000
Total,			30,747,000

III. *Subdivision of the* Yellow Race *into branches, families and nations.*

PERBOREAN BRANCH.

Lapponic family,		9,000	
Samoyedic "		15,000	
Yenisei "		38,000	
Yukagir "		3,000	
Koriak "	Koriaks,	8,000	
	Chutchis,	2,000	
Kamtschatkan family,		5,000	
Esquimaux "	Namollos,	2,000	
	Chugassics,	3,000	
	Kuskovintzes,	7,000	
	Aleouts,	8,000	
	Esquimaux,	20,000	
	Greenlanders,	5,000	
Kurilian family.—Aïnos,		40,000 =	160,000

NGOLIAN BRANCH.

Yakut family.—Yakuts,		90,000	
Mongolian family.—Kalmucks,		170,000	
	Mongolians,	2,560,000	
	Burattish,	120,000	
Tungusian family.—Tungusians,		60,000	
	Mantchurians,	4,000,000 =	7,000,000

IC BRANCH.

Chinese family,	282,000,000	
Corean "	6,000,000	
Japanese "	25,000,000	
Ananitic "	12,000,000	
Siamese "	4,300,000	
Peguan "	500,000	
Birman "	2,500,000	
Thibetan "	6,000,000 =	338,300,000
	Total,	345,460,000

IV. *Subdivision of the* Brown Race *into branches, families and nations.*

NDOO BRANCH.

Hindoo family.	Hindees; Guzurats; Mahrattas; Bengalees; Oriyas; ? Taiganes,	111,100,000	
Malabar family.	Telingas; Carnatics; Tamils; ? Singalese; ? Gonds; ? Bhills; ? Paharias; ? Kacharis, etc....	60,000,000 =	171,100,000

HIOPIAN BRANCH.

Abyssinian family.	Barabras; Tibboos; Abyssinians; Galias, etc.	4,300,000	
Fellan family.—Fellahs; Ovas, etc.		4,000,000 =	8,300,000

LAY BRANCH.

Malay family.	Malays; Battas; Javanese; Macassars; Bugis; Turajas; Dayaks; Bissayis; Tagalis, etc.	24,600,000	
Polynesian family.	N. Zealanders; Tongas; Bougainvillians; Cook's Islanders; Tahitians; Paumotuans; Marquesans; Sandw'h Islanders; Caroline Islanders; Mulgravians,	1,000,000 =	25,600,000
		Total,	205,000,000

V. *Subdivision of the* Red Race *into branches and families.*

Southern branch.		
Aztec family,	4,435,000	
Maya "	300,000	
Quichua "	2,620,000	
Antisian "	100,000	
Araucanian family,	340,000	
Pampean "	250,000	
Chiquitean "	20,000	
Moxean "	30,000	
Guaranian "	1,105,000 =	9,200
Northern branch.		
Floridian family,	70,000	
Iroquois "	5,000	
Lenape "	40,000	
Athabascan "	40,000	
Sioux "	35,000	
Pawnees "	80,000	
Kolushen "	50,000	
Wakash "	20,000	
Californian "	60,000 =	400
Total,		9,600

VI. *Subdivision of the* Black Race *into branches, families and nations.*

Western branch.		
Caffre family, Hottentot " Negro "	A large number of nations, of whom the most are unknown,	56,00
Eastern branch.		
Papuan family.	Feejeeans; New Caledonians; New Hebrideans; Salomon Islanders; Papuas,	1,00
Andamanian family,	Andamans of the Andaman Isl., Indo-China, New Guinea, New Holland, Van Diemens Land,	
	Total,	57,00

6. *Artesian Wells in Sahara*, (Athen., No. 1562).—The *Moniteu gérien* brings an interesting report on the newly-bored Artesian we the Sahara Desert, in the province of Constantine. The first well bored in the Oasis of Oued-Rir, near Tamerna, by a detachment o Foreign Legion, conducted by the engineer, M. Jus. The works begun in May, 1856, and, on the 19th of June, a quantity of wat 4,010 litres per minute, and of a temperature of 21° Réaumur, ru forth from the bowels of the earth. The joy of the natives was bounded; the news of the event spread towards the South with une pled rapidity. People came from long distances in order to see miracle; the Marabouts, with great solemnity, consecrated the ne created well, and gave it the name of "the well of peace." The se well, in Temakin, yielded 35 litres, of 21° temperature, per minute, from a depth of 85 metres; this well was called "the well of bliss.' third experiment, not far from the scene of the second, in the Oa Tamelhat, was crowned with the result of 120 litres of water per mi The Marabouts, after having thanked the soldiers in the presence o whole population, gave them a banquet, and escorted them in sol

procession to the frontier of the Oasis. In another Oasis, that of Sidi-Nached, which had been completely ruined by the drought, the digging of "the well of gratitude" was accompanied by touching scenes. As soon as the rejoicing outcries of the soldiers had announced the rushing forth of the water, the natives drew near in crowds, plunged themselves into the blessed waves, and the mothers bathed their children therein. The old Emir could not master his feelings; tears in his eyes, he fell down upon his knees, and lifted his trembling hands, in order to thank God and the French. This well yields not less than 4,300 litres per minute, from a depth of 54 metres. A fifth well has been dug at Oum Thior, yielding 108 litres per minute. Here a part of the tribes of the neighborhood commenced at once the establishment of a village, planting at the same time hundreds of date-palms, and thus giving up their former nomadic life. The last well is that of Shegga, where soon an important agricultural centre will spring up. There is no doubt but that these wells will work in these parts a great social revolution. The tribes which, after the primeval custom of their ancestors, kept wandering from one place to another, will gather round these fertilizing springs, will exchange the herdsman's staff for the plough of the farmer, and thus take the first steps towards a civilization, which, no doubt, will make rapid progress in Northern Africa.

7. *Ascent of Chimborazo*, (Ed. N. Phil. J., vi, 370).—The *Echo du Pacifique* of the 3d January, gives the following account of an ascent of Chimborazo, made on the 3d November, 1856, by a French traveller, M. Jules Remy, accompanied by M. Brenchley, an English traveller.

"On the 23d of June, 1802, the illustrious Humboldt, accompanied by his friend Bonpland, made the first attempt to ascend Chimborazo. On account of a pointed rock, which presented an insurmountable barrier, they were unable to ascend above 5909 metres of the mountain, then regarded as the highest in the world, and which still occupies a principal place among the colossi of America.

"Thirty years later, on the 16th of December, 1831, M. Boussingault, after a long and skillful examination of the Cordillera of the equator, endeavored to accomplish the ascent in which his predecessor had failed. He reached the enormous height of 6004 metres, that is to say, 95 metres higher than the others; but he was arrested by rocks as they had been, and could not get beyond this limit, which was then the most elevated point ever attained by man on mountains.

"The accounts of these famous travellers had deprived us of all hope of reaching a height so considerable; but, after having observed the snowy and rounded summit of Chimborazo from Guayaquil, we could not help thinking that it was accessible from some point or other. M. Brenchley and myself were thus led to form the design of attempting a third ascent.

"On the 21st of July, 1856, as we crossed the plateau of the Andes on our way to Quito, we halted at the foot of this stupendous mountain. We employed two days in studying its outlines from a distance, with the view of discovering any peculiar places on the surface of its gigantic dome which might afford us a passage.

"The route followed by MM. Humboldt and Boussingault, seemed to us at first to be greatly the most easy and desirable on account of its

regular declivity; but the barrier of rocks, which we readily distinguished, presented no outlet to the eye. When we had made nearly the entire circuit of this mighty mountain, and without success, we resumed our journey towards Quito, reserving the execution of our plan till we should be better fortified against the rigorous climate of the higher Cordilleras.

"After visiting Pichincha, Cotopaxi, and other giants of the Andes, we again found ourselves, on the 2d of November, at the foot of Chimborazo. We pitched our camp at a height of 4700 metres, a little below the line of perpetual snow, in a valley between Arenal and the point where the Riobamba route separates from that of Quito. We intended to spend the following day in collecting plants and hunting deer and birds, endeavoring, at the same time, to determine beforehand the places which might afford us the most easy access to the summit.

"We took up our quarters under a huge inclined rock, which afforded us sufficient protection against the northwest wind, but gave us no shelter in the event of rain. Rain had fallen in the afternoon. The weather cleared at night-fall, the sky became sprinkled with myriads of stars, and Chimborazo was delineated, in all its splendor, on the azure and sparkling vault of the firmament.

"On the morning of the 3d of November, at five o'clock, when day had not yet dawned in the equinoctial regions, we left our camp in charge of our people, and departed on our exploring expedition, carrying with us a coffee-pot, two thermometers, a compass, matches, and tobacco. A steep hill, sandy and rough with pebbles, which separated us from the perpetual snow, occasioned us so much fatigue at our outset, that two of the natives who accompanied us became discouraged and turned back.

"When we had surmounted this hill, we descended on some soft sand to the bottom of a valley, which we followed, and from the extremity of which, we distinguished very clearly the summit of the mountain, entirely free from snow.

"After walking half an hour on the snow, vegetation suddenly ceased, and we saw no other living thing but two large partridges, and on the rocks a few lichens of the families Idiothalamus and Hymenothalamus. At this point of our ascent we collected some dry branches of chuquiragua, and made a bundle of them which we tied to our backs. We had still to scale an immense rock of trachyte, from the top of which the summit of Chimborazo appeared to us so near, that we thought we could reach it in half an hour.

"Our ascent was so rapid, that we were soon obliged, from fatigue, to make frequent stoppages to recover our breath. Thirst also began to be severely felt, and in order to moderate it, we almost always kept snow in our mouths. But we felt no symptoms of illness or any morbid affection, such as is spoken of by the majority of travellers who have ascended high mountains.

"After halting a few seconds, without even seating ourselves, we again started not only with renewed ardor, but even a kind of furious determination inspired by so near a view of the summit. It appeared evident to us, by this new instance confirming so many previous ones, that at these heights the atmospheric column is still sufficient to prevent any impediment to respiration, and that the shortness of breath and organic

ections which are so generally complained of at considerable elevations, ıst be ascribed to some other cause.

"Always rapidly ascending, we now began to overlook the peaks of ; Cordilleras, and to discover a distance furnished with immense valleys, ıen some light vapors, which at first appeared only like spiders webs the sides of the mountains, soon began to detach themselves in the m of white flakes, stretching nearer and nearer to each other, till they last arranged themselves like a girdle along the horizon.

"All of a sudden, about eight o'clock, this curtain enlarged itself, and proached Chimborazo; then in a few minutes, it mounted to us, thin first, but becoming perceptibly more dense. We no longer could perve the summit. We continued, however, to mount upwards, enticed the hope of attaining our object much more easily than we had supsed on leaving our encampment.

"The fog continued to increase; we could not see twenty paces from . At half-past nine, it had become so thick that it was almost as dark night at the distance of a few meters. Confident of finding our footps again to guide our descent, we travelled on with additional stubrnness; but we had every moment to examine the compass, in order to oid a precipice which we had left on our right before reaching the terinal depression by which we resolved to gain the summit.

"It seemed to us that the declivity became less steep, we breathed more ely, and walked with less effort. Some dull detonations began at inrvals to be heard in the distance. At first we ascribed them to the exosions of Cotopaxi; but soon reverberating peals, such as are heard ıly in the vicinity of the equator, convinced us that thunder was rolling the lower regions. A terrible storm was in preparation.

"In the fear that the hail or snow would efface the marks of our feet, nd thereby expose us to the risk of losing ourselves in the descent, we etermined, with regret, to halt for a while. We hastened to kindle our ıuquiragua wood, in order to melt the snow in our coffee-pot. At ten 'clock, the thermometer which, at five feet above the snow, indicated 1·7, 'as plunged in boiling water where the mercury stood at 77·5.

"At five minutes past ten, our observations terminated, and we began) descend with giant strides in order to regain our encampment as peedily as possible. We arrived there in the midst of the thick fog bout an hour after noon. The thunder rolled almost without interrupon, the flashes of lightning describing dazzling zigzags around us, never en elsewhere so distinctly defined except in pictures.

"About three o'clock, a fearful tempest of rain, hail, and wind assailed s under our rock. It continued throughout a part of the night with a ıry which seemed as if it could never be allayed. We were literally ring in water. On the morrow, at day break, our eyes rested everyhere on a vast field of hail.

"Certain indications of another tempest made us abandon the idea of ying again the ascent of Chimborazo, which we henceforth regarded as uite impracticable. We made all haste to break up our camp and make ır Guaranda, where we arrived about three o'clock, travelling through cold and dense fog, which prevented us for that day admiring one of he most beautiful views in the world.

"When we calculated our observations, we were not a little surprised to find that we had reached the summit of Chimborazo without being aware of it. According to personal researches, made at first in the Archipelago of Hawaii, and afterwards repeated among the Cordilleras of the equator, the co-efficient of the sum of degrees or fractions of a degree in the centigrade thermometer, reckoning between the point to which the mercury rises when the instrument is immersed in boiling water, and the boiling point of water at the level of the sea, is found to be 290·8; that is to say, each degree below 100 indicates a difference of level equal to 290·8 meters, or about 29 meters for the tenth of a degree, hence the formula

$$x = (100 - B)\ (290{\cdot}8)$$

which gives us 6543 meters for the absolute vertical height we had reached on Chimborazo. This figure places us quite on the summit, the altitude of which, above the sea level, according to Humboldt's triangulations, is 6544 metres. But whatever degree of confidence may be conceded to our calculations, the unquestionable fact resulting from our ascent is, that the summit of Chimborazo is accessible."

8. *New Electrotype Processes*, (Proc. Brit. Assoc., in Edin. N. Phil. Jour., Vol. vi, No. 2, p. 306).—M. L'ABBE MOIGNO read a paper upon *Three New Electrotype Processes*, and exhibited specimens of considerable interest. The first of these improved processes consists in the employment of platina wires instead of copper, and of making a skeleton figure resembling roughly the outline of the cast sought to be obtained, by means of which, according to M. Lenoir's process, busts, statues, and groups can be produced in full relief by a single operation. The second of these consists in M. Oudrey's process for galvanizing or coppering iron and cast-iron to any thickness required without the cyanid bath. He added remarks upon its employment in commerce and in the navy. The process was not fully communicated, as it is commercially desirable to keep it a secret, but sufficient was communicated to show that the cyanid bath, which is not only expensive but dangerous, can be dispensed with, and that the present system, according to which there is a great waste of material, is avoided, although the substance that is placed upon the iron to induce the deposit of the copper is not stated. The last branch of the paper treated of Messrs. Christofe and Bouillet's process for strengthening electrotypes, the principle of which is to leave an opening in the back of the thin electrotype obtained by precipitating, and to put into it various little pieces of brass, which, on being melted with an oxyhydrogen blast, become diffused all over the interior surface of the copper without injuring it in any way, and thereby impart to it the strength of cast-iron.

9. *On a new method of Refining Sugar;* by Dr. DAUBENY, (Proc. Brit. Assoc., from Edin. N. Phil. Mag., vi, 304).—Dr. Daubeny gave an account of *a new method of refining sugar*, conducted at Plymouth by Mr. Oxland, and known by his name. It consists in the adoption of the superphosphate of alumina in conjunction with animal charcoal, as a substitute for the albumen usually employed for that purpose. In both cases the object is to separate and carry down the various impurities which color and adulterate the pure saccharine principle present in the syrup expressed from the cane or other vegetable which supplies it. As, how-

›ullock's blood is the material usually procured for the purpose of
ing the albumen, a portion of uncoagulated matter, together with
ı salts, is left in the juice in the ordinary process of refining, which
s its purity and promotes its fermentation—thus occasioning a cer-
ss of saccharine matter to result. Nothing of the kind happens
the superphosphate is substituted, and so much more perfect a pu-
on of the feculent matters, under such circumstances, takes place,
everal varieties of native sugar, which, from being very highly
d with feculent matters, are rejected in the ordinary process of re-
are readily purified by this method. The employment of super-
hate of alumina also gets rid of so much larger a portion of the
ities present in the sugar, that much less animal charcoal is subse-
y required for effecting its complete clarification than when bul-
blood has been resorted to. The quantity of superphosphate neces-
r effecting the object is, for ordinary sugars, not less than twelve
to the ton; whereas, for the same quantity, as much as from one
gallons of bullock's blood is found to be required. Dr. Daubeny
ted that this reagent might be advantageously resorted to not only
purification of sugar, but also in other processes of the laboratory,
the removal of foreign matters, intimately mixed with the solution
efinite component, becomes a necessary preliminary in its further
ation.

Report on the Development of Heat in Agitated Water; by Mr.
NNIE, (Proc. Brit. Assoc., Athen., No. 1559).—Mr. Rennie, in allud-
his former papers on the subject, read before the Section last year,
ltenham, stated that the subject of the mechanical or dynamic
equired to raise a given quantity of water one degree of Fahren-
ad long been the object of the research of philosophers, ever since
Rumford, in his celebrated experiments on the evolution of heat in
guns when surrounded by ice or water, proved the power required to
ne pound of water one degree, and which he valued at the dynamic
lent of 1,034 lbs. M. Moya was the first who announced that heat
volved from agitated water. The second was Mr. Joule, who an-
ed that heat was evolved by water passing through narrow tubes,
this method each degree of heat required for its evolution a me-
al force of 770 lbs. Subsequently in 1845 and 1847 he arrived at a
ical equivalent of 772 lbs. These experiments have since been con-
by other philosophers on the Continent. In the present paper
ennie stated that his attention was called to the subject by observ-
e evolution of heat by the sea in a storm, by the heat from water
g in sluices. He, therefore, prepared an apparatus similar to a
churn, somewhat similar to that adopted by Mr. Joule, but on a
scale. In the first case he experimented on fifty gallons, or 500 lbs.
ter, inclosed in a cubical box, and driven by a steam engine instead
eight falling from a given height, as in Mr. Joule's experiment;
lly, on a smaller scale, by 10 lbs. of water inclosed in a box. The
machine or churn was driven at a slow velocity of eighty-eight
tions per minute, and the smaller machine at the rate of 232 revo-
s per minute, so that the heat given off by the water in the large
as only at the rate of three and a half degrees per hour, including

the heat lost by radiation; whereas the heat evolved by the ten gallons of water contained in the small box agitated at 232 revolutions was fifty-six degrees Fahrenheit per hour. Thus the temperature of the water in the large box was raised from 60 degrees to 144 degrees, and the temperature of the water in the small box to boiling point. As an illustration, an egg was boiled hard in six minutes. The mechanical equivalent in the first case was found to approximate nearly to that of Mr. Joule, but in the latter case it was considerably above his equivalent, arising, very probably, from the difficulty of measuring accurately the retarding forces.

11. *Fossils of South Carolina;* by M. Tuomey and F. S. Holmes.—Along with Nos. 13, 14, 15 of this fine work,—the most beautiful in style of any work on American Palæontology,—we have received the following circular from Professor Holmes, and have the pleasure of adding that the Legislature has authorized its continuation. There will be two more volumes issued, one on the Eocene and one on the Post-pleiocene. The volume just closed contains figures and descriptions of 203 species; 42 per cent. are still living.

Circular.—We have great satisfaction in announcing to the subscribers the publication of our fifteenth and last number. This completes one entire volume, devoted to the Pleiocene Fossils of South Carolina.

In the accomplishment of this cherished design, we have labored assiduously for more than five years, and expended a large sum of money. The receipts will apparently do no more than defray actual expenses; but we do not repine, being recompensed for our toils by the success of publishing a scientific work at home, in the best style of art. To the accomplishment of this object, all our endeavors have been directed.

Should the Legislature continue the subscription in this State, it is proposed to proceed with the work and publish one volume on the Post-Pleiocene, and one on the Eocene Fossils. Should this be the final determination, due notice of our purpose will be given in a prospectus; and we shall hope to receive a continuation of the patronage so liberally given to the first volume.

12. *On the Direction and Velocity of the Earthquake in California of January* 9, 1857; by Dr. John B. Trask.—The earthquake which occurred in various parts of this State on the morning of the 9th of January last, excited at the time considerable attention. This arose from two causes; first, from the varied reports that appeared on the following day through the press of this city, detailing its occurrence in remote mountain towns, and for which there was no foundation; secondly, from the great extent over which the commotion was felt, as was subsequently proved.

Immediately following the occurrence of the phenomenon, letters were addressed to all the principal towns between Mariposa and Downieville, east of the valleys, for the purpose of learning how far the shocks may have extended eastward of this city. These letters were forwarded by the Pacific Express Company to their agents, and through them answers were returned in every case but two through the same source. From the facts thus obtained, it was found that in no locality east of the foothills, *was any shock felt whatever on that day or night.*

Another report, equally unfounded, reached us on the arrival of the steamer from the southern coast, to the effect that several houses had

›lished in San Diego from its violence, while the facts in the *hat the steamer left that port twenty-four hours before the shock here.*

·thquake, or more properly speaking, the series of shocks that the night of the 8th in this city, and which continued in the t of the State during the following day and night of the 9th, bly the most extensive of any on record on this portion of the ıst, excepting, perhaps, that of the wave of the Simoda earth- December, 1854. The linear distance over which we are able course, amounts to six hundred and two miles, and its breadth, now ascertained, is two hundred and ninety miles. It has all rance of having been the terminal movement of some more nmotion at a distance from our coast.

ıe best evidence attainable at present, it seems to have had its he west and travelled in an easterly direction. This is conclu- ·ed from the fact that it was felt earlier at San Francisco, than her locality east of this city within the State. We have no yet of its occurrence along the coast of Mexico or Oregon.

›een able to determine, with considerable accuracy, the period of hich the shock between eight and nine o'clock on the morning took place, at four localities east of the city of San Francisco, ıte; the shock at that hour seems to have been more gene- ed than those which either preceded or followed it, here or else- ›ugh at this city, it was much less marked than the shocks at 15^{m}, and 7^{h}, these three latter occurring at those hours of ng when most persons are sleeping. The shock at 7^{h} produced motion in the pendulum, the diameter of which was about five 'he oscillations of the pendulum in all the others were in an ıd westerly direction.

cise period of time at which the shock took place at San Fran- een eight and nine o'clock, is determined by the stopping of a belonging to J. W. Tucker, whose rate of error was three sec- The time at San Diego was furnished by Mr. Cassidy of the that of the Tejon Reserve is by persons at that post. To pri- ›men at Sacramento and Stockton we are indebted for the time aces. The accompanying table of latitudes and longitudes, of ıamed, gives the hour at which the shock took place at each; ıce or elapsed time, from which the velocity was deduced, are times corrected for the places named, the time as given above n as the standard at San Francisco.

·oper here to state that three minutes four seconds was the ror in time found, and the least was twenty-two seconds:—

	Lat.	Lon.	Time of shock.	Elapsed time.	Velocity.
	° ′	° ′	h. m. s.	m. s.	miles.
·co, ...	37 48	122 25	8 13 30	0 00	0 0
', ...	38 32	121 23	8 20 00	7 30	6 6
....	37 52	121 34	8 23 00	9 30	6 5
....	35 00	118 46	8 45 00	32 30	6 0
....	32 42	117 13	8 50 00	36 30	7 0

The velocity is given in miles per minute; and by dividing the sum of the same by their number, it will be found that the movement of the wave at that time averages a fraction over 6·2 miles per minute.

The results obtained from the above data approximate closely to the deductions of Prof. Bache on the wave which reached our shores resulting from the earthquake at Simoda on the 23d of December, 1854, and which will be found in a paper read by that gentleman at the meeting of the American Association for the Advancement of Science, during the early part of last year.

From the facts before us, there can be little doubt of the direction of the commotion, and that it proceeded from the west, or a little south of that point. The motion of the earth, as described at the different localities at which it was felt, with the motion of the pendulum—which was slightly south of a west line—leads to the latter conclusion. Time is an important element in aiding us to form correct conclusions regarding their phenomena, and it is to be hoped that our friends in different parts of the State, in reporting the same, will be precise in this particular. Of the incidents attending the shocks, many and varied reports have reached us; and it seems to have acted with greater violence in the vicinity of the Tejon Reserve and upper Tulare county than at any other places. It is most remarkable that so small an amount of intensity was manifested when the area over which it extended is taken into consideration.

The effects were felt in San Francisco several hours before they are reported to have been observed at any other place north or south. They began here at twenty minutes past eleven, on the night of the 8th, and continued till thirteen minutes past eight the following morning—six shocks occurring in the interim; while to the south, the first shock that was noticed at the Tejon was at 6 hours 30 minutes, on the 9th. In Los Angeles they continued at long intervals through the day until 23 hours 30 minutes of the same date. I have learned from persons who were present in Los Angeles at this time, and also at the shock of the 14th of July, 1855, that the severity of the latter exceeded that of the 9th of January last.

13. *Action of Light.*—Niepce de St. Victor, distinguished in photography, has recently made some farther discoveries with regard to the action of light. The question which he has aimed to answer, is this,—Does a body, which has been exposed to light, preserve any of the effect when carried to a dark place? Phosphorescence and fluorescence are well known examples of such an effect; but these are not all. On exposing to the sun's rays an engraving which had been for some days in the dark, one-half covered with an opaque shade, and then applying this engraving to very sensitive photographic paper for twenty-four hours in the dark, the white parts of the portion not covered are reproduced in black; while the same engraving treated thus, without exposure to the light, produces no effect. Pictures on all kinds of paper, wood, ivory, parchment, produce the same result, through in different degrees, but not when on metals. An interposed plate of glass, mica, quartz crystal, or yellow glass colored with oxyd of uranium, prevent the action, as they also do, as recently proved, the phosphorescent property. A coat of collodion

›t interfere with the result, though common varnish does. The ıkes place if the sensitive paper is not in contact with the engrav- ı design traced on white paper with a fluorescent liquid, as sulphate ine, exposed to the sun and then applied to the sensitive paper ıces itself much more rapidly and strongly than the white paper; rst exposed to the sun there is no effect. Luminous lines of phos- act without exposure to the sun, but not if glass be interposed.

General View of the Animal Kingdom; by A. M. REDFIELD. A neasuring 5 feet by 4½. New York City and Hartford, Ct.: E. B. & :ellogg.—This handsome engraved chart is an exhibition of the ation of the Animal Kingdom, by an arrangement of branching livided off according to the classes, orders, families, etc. The four of the Radiates, Mollusks, Articulates, Vertebrates, with their suc- subdivisions sweep gracefully over the chart, without any fanciful ; out of a tree; and in addition to the lettering of the branches, s quite detailed, there are well engraved figures of species in large s, making an exhibition of the Animal Kingdom of real value for struction. The figures among the Mammals include half a dozen of Monkeys, fifteen or twenty of Carnivora, nearly as many of ta or hoofed Quadrupeds, and so on through all the groups in the Sub-kingdoms. The plan is excellent, and it is well carried its accomplished authoress. We could wish some small changes ı the classification. But the chart, as it is, will be found of great ce to the teacher, and should be in all the academies and higher of the land. It speaks to the eye, and more impressively than a of text.

Reports of Explorations and Surveys to ascertain the most practica- economical route for a Railroad from the Mississippi River to the Ocean, made under the direction of the Secretary of War in , according to acts of Congress of March 3, 1853, May 31, 1854, gust 5, 1854. 4to. Vols. 2, 3, 4. Washington, 1855, 1856.— veys for the railroad to the Pacific have already been briefly no- ı this Journal. The Reports, before published in brief, are here t out with full details, and include a large amount of natural sci- ; well as general geographical information. The collections we and have been great, and now constitute part of the very large of American Natural History at the Smithsonian Institution. The ıg are the contents of the volumes here announced.

II. 1. Report of Explorations near the 38th and 39th parallels of atitude made by Capt. J. W. Gunnison, Topog. Eng., made by E. G. Beckwith, Third Artillery. 128 pp. with plates.—Capt. Gun- t will be remembered, died at the hands of the Indians while car- orward his surveys. Page 94 to 112 are occupied with tables of ›logical observations.

eport on the line of the 41st parallel, by Lieut. E. G. Beckwith. . with plates: Meteorological observations occupy pages 71 to 95; ›gical Report by James Schiel, M.D., Geologist of the Expedition, ›6–111, and a letter on Infusorial Fossils by Prof. J. W. Bailey, on 11, 112. The paper by Dr. Schiel is illustrated by four lithographic containing figures of some Carboniferous and Cretaceous fossils.

3. A Report on the Botany of the two Expeditions by John Torrey and Asa Gray, covering pages 119 to 132 and illustrated by ten plates.

4. Synopsis of a Report of the Reconnaissance on the route from Puget Sound via South Pass to the Mississippi river, by Fred. W. Lander, Civil Engineer. 44 pages.

5. Report of Exploration on the route near the 32nd parallel from the Red River to the Rio Grande, by Brevet Captain John Pope, Corps Topog. Eng. 156 pages. It concludes with a Report on the Botany of the Expedition by John Torrey and Asa Gray, pp. 157–178, with ten plates.

6. Report on the Geology of the route near the 32nd parallel, by Wm. P. Blake. 50 pages, with a map, and a section across the mountains.

7. Report of Explorations near the 32nd parallel between Doña Ana on the Rio Grande and Pimas Villages on the Gila, by Lieut. John G. Parke. 28 pages.

8. Extract from a Report of a Military Reconnaissance made in 1846, 1847, by Lieut. Col. W. H. Emory. 22 pages.

Vol. III. Report of Lieut. A. W. Whipple, Topog. Eng., on the route near the 35th parallel. 36, 136, and 77 pages, with plates.

2. Report upon the Indian Tribes, by Lieut. A. W. Whipple, Thomas Ewbank, Esq., and Prof. Wm. W. Turner. 127 pages, with plates of Indian relics, vocabularies of the languages, etc.

3. Report on the Geology of the route by Wm. P. Blake, 175 pages, including, with Mr. Blake's account, the Report of Jules Marcou, and descriptions of the Fossils by James Hall, and illustrated by maps, sections, and plates of fossils.

Vol. IV. 1. Report on the Botany of the Expedition under Lieut. Whipple. Embracing—1. General descriptions of the Botanical character of the country, by J. M. Bigelow, M.D.; 2. Description of Forest Trees, with a map illustrating Geographical Distribution, by J. M. Bigelow, M.D.; 3. Description of the Cactaceæ, with 24 plates, by G. Engelmann, M.D., of St. Louis and J. M. Bigelow, M.D.; 4. Descriptions of the General Botanical Collections, with 25 plates, by John Torrey; 5. Description of the Mosses and Liverworts, with 10 plates, by W. S. Sullivant.

2. Zoology of the Expedition. Field notes and explanations, by C. B. R. Kennerly, M.D. (17 pages).—The remainder of the Zoological Report is deferred to another volume; and we doubt not that the volume will be one of great scientific value.

3. Appendices to the volume, including astronomical, magnetic, and climatological observations.

We rejoice that the General Government has carried forward so liberally publications like the above, illustrating the geography, history and natural productions of the country. And we trust the work may go on under the same auspices, and on a scale no less liberal, until the land is thoroughly searched out, and a series of volumes covering fully the great subjects shall be in all its prominent libraries.

16. *Report of the Geological Survey of the State of Vermont;* by Edward Hitchcock, State Geologist. 12 pp., 8vo. Montpelier: 1857.—The Vermont geological survey has been in progress during the past year under the direction of Prof. Hitchcock. This Report is a brief statement with respect to the funds and means necessary for the continuation of the survey.

17. *Flora from the Appalachian Coal field;* by JAMES P. KIMBALL of Salem, Mass. An Inaugural Dissertation for the degree of Doctor of Philosophy, addressed to the Philosophical Faculty of the University of Göttingen. 32 pp., 8vo, with 3 lithographic plates.—A number of species of fossil plants from Pennsylvania are described and figured in this pamphlet, pertaining to the genera Neuropteris, Alethopteris, Hemitelites, Sigillaria, Syringodendron and Lepidodendron.

18. *On the Determination of Altitudes, from Observations taken with the Barometer;* being Chapter VI and Appendix E of the Report of Lieut. HENRY L. ABBOT, Corps of Topog. Eng., upon Explorations for a Railroad Route from the Sacramento Valley to the Columbia River, made by Lieut. R. S. Williamson, Topog. Eng., assisted by Lieut. Henry L. Abbot, Topog. Eng., in 1855.

19. *Uber neue Echinodermen des Eifeler Kalkes;* von JOH. MÜLLER. 30 pp., 4to, with 4 plates. Berlin. From the Transactions of the Königl. Akad. Wissensch. zu Berlin, 1856.—Prof. Müller has described in this paper several of the Crinoids from the Eifel (Devonian) limestone. The species are of the genera *Taxocrinus, Hexacrinus, Trichocrinus* (Müller), *Nanocrinus* (*Müller*) and *Poteriocrinus*. Besides these, *Lepidocentrus Eifelianus* (Müller) is an Echiniform species from the Eifel.

20. *Topographical and Geological Report of Chester Co., Pennsylvania;* by W. D. HARTMAN, M.D. 12 pp., 8vo, with a colored geological map. Philadelphia, 1857. Extracted from the Transactions of the Pennsylvania State Medical Society.—Chester County, Pennsylvania, has great interest to the mineralogist, on account of the large number of fine minerals it affords in connection mostly with its serpentine and limestone and lead and copper veins. This paper, though mainly medico-topographical, contains valuable mineralogical and geological observations; and a geological map gives it special value.

21. *Determinative Mineralogy:* Tables for the determination of minerals by help of simple chemical experiments; by FRANZ VON KOBELL, Prof. of Mineralogy in the University of Munich. Translated from the last German edition and the Author's manuscript notes, and prefaced by a complete treatise on the Use of the Blowpipe, by Professors G. J. BRUSH and S. W. JOHNSON of the Yale Scientific School.—This work—one much needed in the country—we understand will soon be published.

22. *Volcano of Hawaii.*—In the article on page 136 respecting the volcano, Mauna Loa, it is stated that the Rev. Mr. Coan regards the lavas of the late eruption as having flowed from a single opening. It should be added that he supposes this opening may have been a fissure or series of fissures extending ten or fifteen miles from the highest point; but that for the lower forty miles there were no openings supplying the flow of lava.

23. *Organic Morphology.*—The work on Organic Morphology noticed in our last volume at page 443, was by JOHN WARNER.

24. *Chemistry.*—An accomplished student in Science, who has spent several years in the laboratories of Professors Liebig and Agassiz, is desirous of obtaining a situation as Professor of Chemistry, or of this and Natural History combined. Reference may be made to Professors Agassiz or Gray of Cambridge, or to the Editors of this Journal.—EDS.

J. M. SAFFORD and RICHARD OWEN, M.D.: Report of the Mineral and Agricultural Resources of the lands owned by the Hopkins Mastodon Coal and Iron Mining and Manufacturing Company. 52 pp. 8vo, with a map.

The Parish Will Case, before the Surrogate of the City of New York: Medical Opinions on the mental competency of Mr. Parish, by Drs. John Watson, D. T. Brown, M. H. Ranney, Pliny Earle, Luther V. Bell, I. Ray, Sir Henry Holland, Bart. 574 pp. 8vo. New York, 1857.

J. J. GRIFFIN: The Radical Theory in Chemistry. Crown 8vo. *London.* 1857.

R. BUNSEN: Gasometry; comprising the leading Physical and Chemical Properties of Gases, together with the methods of gas analysis. Translated by H. E. Roscoe. 8vo, with 58 illustrations. *London.* 1857.

Prof. ALLMAN: British Freshwater Zoophytes. 4to, with 11 colored plates. Published by the Ray Society, London.

The *Ray Society* will also publish A Monograph on the Oceanic Hydrozoa (Jelly-Fishes) by Prof. Huxley; A Monograph of the British Foraminifera, by Prof. Williamson; A General History of the Foraminifera, by Dr. Carpenter; A Monograph of the British Sponges, by J. S. Bowerbank.

ADAM WHITE: A Popular History of British Crustacea. 12mo. *London.* 1857.

CHARLES PICKERING: The Geographical Distribution of Plants and Animals. 4to, (vol. xv, of the U. S. Exploring Expedition under Capt. Wilkes). *Boston.* Little, Brown & Co. In cloth $3.00.

JULIUS VICTOR CARUS: Icones Zootomicæ,—a general and systematic work on the Anatomy of Animals. 1st part, devoted to the Invertebrata, each group being illustrated by very numerous figures on 23 folio plates. The remaining part will contain the Vertebrata. Received too late for a further notice in this number.

FRANK BUCKLAND (son of the late Dean Buckland): Curiosities of Natural History. 8vo. *London,* 1857. Bentley.

O. G. COSTA: Fauna del Regno di Napoli, etc. Fasc. 96 to 99 have appeared. 152 pp. 4to, with 15 colored plates. *Naples,* 1857.

G. P. DESHAYES: Description des Animaux sans vertèbres, découverts dans le bassin de Paris,—a Supplement to Deshayes's former work on the Fossils of the Paris Basin, and comprising a general review of all the known species. p. 161 to 240, 4to, with 10 plates. *Paris,* 1857.

E. DESOR: Synopsis des Echinides Fossiles. Livr. 1-4, 4to. 240 pp. 30 plates. *Paris.* 1857.

Faune Française, ou Histoire Naturelle, Générale et Particulière des Animaux qui vivent en France: par CHARLES LUCIEN BONAPARTE et VICTOR MEUNIER. A Prospectus of this "French Fauna" has just been issued. As projected, the work will extend to 24 volumes 8vo, one to be issued every three months, the first, in Jan. 1858. It will contain very numerous wood-cuts, and colored engravings, and will be the most complete and elegant work of the kind that has ever been published. Subscriptions are solicited.

TH. LACORDAIRE: Histoire Naturelle des Insects—Genera des Coléoptères. Tome IV, 583 pp. 8vo. *Paris,* 1857.

A. MACHADO: Catalogos de los Peces, etc.: Fishes of Cadiz and Huelva and of the river Guadalquiver. 30 pp. 4to. *Seville,* 1857.

PROCEEDINGS BOSTON SOC. NAT. HIST., Vol. VI. p. 253, Corrosion of living shells. p. 260, Astræa decactis, a new species of coral; *T. Lyman.*—p. 264, Vibrations at the dam at Hadley Falls; *C. Stodder.*—p. 269, Peculiar mode of gestation in the Aspredos or Trompettis, etc.; *J. Wyman.*—p. 274, On a new genus and species of Coral, Syndepas Gouldii; *T. Lyman.*—p. 279, Note on Native Iron of Liberia; *A. A. Hayes.*—p. 281, Larva of a Musca or Œstrus found in the skin of the scalp, face, neck and back of a child; *B. S. Shaw.*—p. 282, On the Fungus, Glæosporium Crocosporum; *C. J. Sprague.*—p. 283, On the copper of Lake Superior; *Dr. Kneeland.*—p. 284, Note on a siliceous calculus taken from the Urethra of an Ox; *Bacon.*—p. 287, On a new species of Coral, Oculina glomerata; *T. Lyman.*

PROCEEDINGS OF THE CALIFORNIA ACAD. NAT. SCI.—p. 96, A new species of Quercus; *Dr. Kellogg.*—Telluret of Silver in California; *W. P. Blake.*—p. 98, On the Earthquake of Jan. 9, 1857; *J. B. Trask.*—p. 99, On some new microscopic organisms, with a plate; also on some Sertularidæ and Bryozoa; *Dr. Trask,* with two plates.—p. 102, New marine shells of the Sandwich Islands (species of Murex, Purpura, Turbo, Trochus, Pleurotoma, Rissoa,); *Garratt.*

THE

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[SECOND SERIES.]

ART. XIV.—*An Address in Commemoration of Professor J. W. Bailey, late President of the American Association for the Advancement of Science;* by Dr. A. A. GOULD.

[Delivered before the Association, August 19, 1857.)

Mr. President and Gentlemen of the American Association for the Advancement of Science—We are called upon, at this time, to advert to an event such as has not before occurred in the history of this Association during the seventeen years since its inception. He who was elected at our last session to preside at this meeting, has in the mean time been taken from us. He, whom we all delighted to honor, though he sought not public honors from men, and who required no higher stimulus to his ambition nor reward of his toil than the satisfaction derived from the discovery and elucidation of the works and laws of Nature's God, has left this arena of trial and doubt to meet that God; and in his presence, where faith is turned to sight, we may well believe that he is unfolding with delight, unmingled with doubt, those wonderful works and perfectly harmonious laws which so engaged and delighted him on earth.

It is becoming that we should bestow a few moments in commemoration of his life and labors. There are others, who knew him much better, and were more conversant with his special studies than myself, to whom this office properly belonged; but as in another connection I had gathered some of the items of his history, and had noted the results of his scientific investigations, I have been requested to present them on this occasion.

JACOB WHITMAN BAILEY was born April 29, 1811, in the old town of Ward, Mass. (now Auburn), at the residence of his grandfather, Rev. Isaac Bailey, the first minister of that town. In infancy he was removed to Providence, and there received his early education in the ordinary schools of that day. The limited resources of his family rendered it necessary that he should early engage in some employment; and, at the age of twelve years he was placed at a Circulating Library, where he attracted the attention of visitors by his studious devotion to books. At this time also he began a collection of shells and insects. During a visit of the West Point cadets at Providence, he became acquainted with some of the officers, and then decided to seek admittance to the Military Academy. He received an appointment as cadet in July, 1828, and graduated July, 1832. He was appointed second lieutenant in the Artillery, April, 1833, and was promoted to first lieutenant, February, 1837. During this time he was stationed at Old Point Comfort, Bellona Arsenal, and Fort Moultrie. But with the development of his scientific tastes, military life had few attractions for him; and in 1839 he received the more congenial appointment of Professor of Chemistry, Mineralogy and Geology in the United States Military Academy, which appointment he held, first as assistant, and soon afterwards as principal, until his death. He was married in 1835, and, with his wife and only daughter, then seventeen years of age, was on board the steamer Henry Clay which took fire on the Hudson river, July 28, 1852. After having lowered them succesfully to the water, and received from them the assurance of their safety, he proceeded to follow, when suddenly a volume of smoke and flame veiled them from his view, and they were lost. He had previously been subject to a bronchial affection and occasional spitting of blood, for which he had resorted to Florida the previous winter with decided benefit. But the exertion and exposure on this occasion, together with the intensity of his bereavement, gave him a shock, from which he never rallied. With the exception of an occasional resort to the sea-shore during vacations, he was afterwards obliged to exclude himself almost entirely from society. His health steadily declined; and, feeling the certainty of the issue, he employed his leisure in arranging his papers, his microscopical collections, and his Algæ, so that they might be practically available to his successors. He died on the 27th of February last, at the age of forty-six.

As a man, he was remarkably unobtrusive and modest, gentle in his manners, truthful in his character, cordially beloved by all who had the good fortune to enjoy his acquaintance.

But it is more with his scientific position that we are concerned. His taste for science was very early developed. Begin-

h botany and mineralogy, and passing from these to chemistry, and microscopy, he traversed a large portion eld of natural science. In the departments more espe- ating to his position at West Point, he held a high rank, publications show that he introduced many improve- chemical manipulation. His correspondence, too, shows vas extensively consulted by men of science on some of , difficult points of analysis and general physics. His ions were always of the most careful and accurate char- nd he early began the important practice of making them, accompanied by delineations, leaving nothing to ion or mere indefinite statements; thus having always permanent data for his subsequent papers. The vol- ntaining these, which he denominated "Microscopic ," is, of itself, a surprising evidence of his industry and here are four hundred and fifty sheets, containing about ousand sketches. By his great skill with the pencil he himself independent of artists, an accomplishment, for of which, many of the best observers lose their labors. rawings date back as far as 1838, twenty years ago, and is to trace out the course of his studies, as well as his ngs; for wherever he went, his microscope or his collect- les went with him. At first, we have mostly sketches able and animal tissues, and occasionally an entire ani- lant. In January, 1839, while examining some aquatic e perceived a curious object, a Gomphonema as it subse- proved, which he did not understand. This excited his in that direction, and soon we find many others of the nmon Diatoms delineated. In March, 1839, he sketched ie, to which Ehrenberg gave the complimentary name *ma Baileyi;* and finally he devoted himself with great ne varied objects included under the general term Infu- id also to a department almost equally demanding his microscopist, namely, the Algæ. So far as the Infusoria cerned, he stated, in 1843, that no one else in this coun- studied them; and that it was almost impossible to pro works relating to them. Ehrenberg's work he had not ough he modestly utters the thought that Ehrenberg metime see and correct his paper. He, however, gradu- essed himself of all the important works on those sub- nd became the active correspondent of Ehrenberg, Agardh, Quekett, Ralfs, Harvey, Greville, De Brébis- ntagne, and very many others. Fossil deposits, mud, io, were collected from every quarter for investigation. ous exploring expeditions were laid under contribution: e recently, the objects brought up on the sounding lead oast Survey, and by Lieut. Berryman's line of soundings

across the Atlantic, made in reference to the laying of the telegraphic cable, occupied his attention. In pursuing these examinations, he found the relics from the bottom so well characterized in certain localities and at certain depths, that he suggested the possibility of being able, in some instances at least, to determine the safety or otherwise of a vessel, by an examination of the organisms brought up on the sounding lead, when prevented by darkness, snows or fogs, from deciding by ordinary observations.

Not a little of the obligation of microscopists to Prof. Bailey is due for his labors to improve the microscope. At any rate, few among us have ventured upon the purchase of a valuable instrument, without first consulting him in reference to it, and perhaps taxing him with unwelcome negotiations; and his letters show that numerous applications of this kind must have been a most serious tax upon his time. It is said that his own early observations were made with globules of glass blown by himself. After he became possessed of a proper instrument, many modifications in the construction of the stage and its movements, and in other appendages, were made by him; and it is to his experience and scientific deductions, coupled with the genius and incomparable optical skill of Spencer, that we are indebted for the most powerful microscopes that have yet been made. His masterly and triumphant defense of them against the detractions of transatlantic pens, also exhibits his complete mastery of the subject. One of his last essays was to construct an Indicator, by means of which the place of any object on a slide might readily and certainly be found. No one, in looking at the card, would credit the labor and thought which he, in conjunction with his friends, Judge Johnson and Mr. Gavitt, bestowed upon it. Many futile efforts were made, and many quires were used in correspondence, before the accuracy of its measurements, and a method for the unerring application of it, were satisfactorily accomplished.

At a very early date, Prof. Bailey began to publish the results of his observations,—a duty too often neglected by scientific men. His published papers are very numerous,—more than fifty,—extending as far back as 1837, and up to his very last hours. They were, for the most part, very brief, free from ostentation, aiming to communicate facts in the simplest and most direct manner. In the words of his friend, Prof. Gray, "they are all clear, explicit, and unpretending as they are thorough; and every one of them embodies some direct and positive contribution to science." Most of them were terminated by a condensed statement of the general facts elicited, so as to show, at a glance, the subject and result arrived at. They are mostly to be found in Silliman's Journal of Science, or in the Smithsonian

Contributions to Knowledge, except one in the first volume of the Transactions of the Association of Geologists and Naturalists, which embodied his previous papers on the Infusoria of the United States, with additions, and which gave him at once a high position as a scientific naturalist.

His Microscopical Collection will constitute his most splendid monument. The slides, of which there are five hundred and fifty, are arranged in boxes in the form of octavos, of which there are twenty-four volumes. More than three thousand objects, fixed upon slides, are catalogued and noted with reference to Bailey's Indicator, thus enabling any one readily to find with certainty the identical specimens described by him. There are also very many other slides not included in the regular collection. Being objects either described by himself or given to him by other describers, this collection must always possess the highest authority, and must be our ultimate reference in all cases of doubt.

The collection of Algæ is equally complete and authentic. It consists of thirty-two portfolios, containing about 4,500 specimens; and it may safely be said that few collections in the world are superior to it.

It is probably well known that Prof. Bailey bequeathed his Microscopical Collection, his Collection of Algæ, his books on Botany and Microscopy, his Memoranda and his Scientific Correspondence, to the Boston Society of Natural History. While the Society intends to keep this bequest sacredly, it means also to make it as extensively useful as possible. I hesitate not, in behalf of the Society, to invite all who are pursuing similar researches to consult these collections, whenever convenient,—and to give assurance also, that any questions which may be solved by it may be freely addressed to the Society. A large collection of rough material for microscopic research, from many of the most interesting localities, is also in the possession of the Society, and will be distributed to microscopists and societies.

Such are some of the principal events in the history of our distinguished associate and President, and such are some of the accumulated fruits of his scientific labors,—labors which were performed in addition to the full duties of a professorship, executed with military precision and punctuality. He has won for himself a place by the side of the most eminent microscopists and algologists of the old world, and may well be styled the Ehrenberg of America. He will always stand, in this country, as the father of those branches of Natural History which relate to the *world of atoms*, and must for ever remain the standard reference here in relation to them. Let no man think lightly of them because they relate to little things, too small to be discerned by the unassisted eye. Are they not equally the handi-

work of him who made and sped the spheres, and formed man in his own image? And if he, by the microscope, demonstrated the vegetable structure of coal, illustrated the lowest habitable depths of the ocean, settled the nature of some of the important geological strata, and of the vast deserts otherwise deficient in geological indications,—questions of practical importance in our investigations of the crust of the earth,—let him receive a corresponding rank with him who points the telescope to the mighty orbs above, determines their magnitudes and movements by scientific induction, and thereby enables us to determine our place upon that crust.

I cannot refrain from quoting, in conclusion, the words of an intimate friend in a letter to him, on learning of his appointment as President for this meeting. He says, "I am sure every one acquainted with what you have done for the advancement of science, American science, and American scientific character, will say, that no appointment, at the present time, could be more appropriate or just. I hope the great Disposer of events, whose minute works you have done so much to place before our eyes in all their exquisite beauty of form, of workmanship, and of adaptation, will give you yet many years to enjoy the honors you have so honestly acquired, and to add many more discoveries to those you have already secured." And may I not respond for you all, Would that this desire had been granted!

ART. XV.—*On some remains of Batrachian Reptiles discovered in the Coal Formation of Ohio, by Dr. J. S. Newberry and Mr. C. M. Wheatley;** by JEFFRIES WYMAN, M.D., of Cambridge, Mass.

ONE of the most interesting subjects presented to the palæontologist for investigation, is that relating to the determination of the period when the Creator gave forms to organized beings, and placed them in definite relations with the earth and its atmosphere, and made them living things. But the history of geology shows, that generalizations as to the time and circumstances of the creation of given animal forms have approached precision only, as the depths of the ancient lakes and oceans have been faithfully explored, and the shores and dry lands which coëxisted with them have been accurately explored.

It was during the deposition of the Oolite that reptilian life reached its culminating point; below this, the deeper explorations are carried, the less numerous are the remains of reptiles found to be, and it has been assumed within a few years even,

* A short verbal account of these fossils was given to the Am. Assoc. for the Advancement of Science at their meeting in Albany, in 1856.

that their creation took place during the triassic period. The coal formations had been largely examined, thousands of fishes and still lower animals had been discovered, before the first traces of reptiles came to light in the remains of Apateon and Archegosaurus. After these, there were found the footprints and other remains of other reptiles, discovered or described by Goldfuss,* Burmeister,† Dr. King,‡ Sir Charles Lyell,§ Mr. Lea,‖ Herman Von Meyer,¶ Profs. Dawson,** Owen,†† H. D. Rogers‡‡ and E. Hitchcock.§§ The Telerpeton, discovered by Dr. Mantell, was obtained from the upper layers of the Elgin sandstones; and these some of the leading English geologists have referred to the Old-red. Doubts have recently arisen as to their real age, so that, in the present state of knowledge we cannot refer reptile life to a period older than the Coal. However, in view of our as yet imperfect knowledge of the Old-red fauna, the question may still be raised whether we have even now reached the period of primoidal reptiles.

The remains described in this paper are important additions to the proofs of the presence of reptilian life during the Carboniferous epoch, showing the existence of at least three species and

* Beiträge zur vorweltlichen Fauna des Stein-kohlengebirge. Bonn, 1847, 4to. Also in Leonhard and Bronn Jarhbuch, 1847, p. 400.

† Die Labyrinthodonten aus dem saarbrucker Stein-kohlengebirge, Pt. III, Archegosaurus, Berlin, 1850.

‡ Description of fossil footmarks (of *Thenaropus heterodactylum*) found in the Carboniferous series, in Westmoreland Co., Penn., by Alfred T. King, M.D., Am. Journal of Science, vol. xlviii. p. 343, and in vol. i, new series, p. 268.

§ On the evidence of fossil footmarks of a quadruped allied to Cheirotherium in the Coal strata of Pennsylvania, by Charles Lyell, Esq., F.R.S., &c., Am. Journal of Science, vol. ii, new series, p. 25.

Also on the remains of a reptile, (*Dendrerpeton Acadianum*, Wyman and Owen,) and of a land shell discovered in the interior of an erect fossil tree, in the coal measures of Nova Scotia, by Sir Charles Lyell, F.R.S., &c., and J. W. Dawson, Esq. Quarterly Journ. of the Geol. Soc., London, May 1853, vol. ix, p. 58.

‖ On Reptilian footmarks in the gorge of the Sharp Mountain near Pottsville, Penn., by Isaac Lea, Esq. Proceedings of the Am. Phil. Soc., 1849, p. 91; also in the Am. Journ. of Science, vol. ix, new series, 1850, p. 124. And Trans. Am. Phil. Society, vol. x, Art. xxi, p. 308; and in his splendid mongraph, grand folio, 1855.

¶ H. de Von Meyer. Palæontographica I, p. 112. The reptilian nature of Archegosaurus has been disputed, but the investigations of Von Meyer based upon an examination of the remains of a great number of individuals belonging to two species, have shown that in addition to double occipital condyles, this animal possessed well developed arms and legs, which are sufficient to establish its reptilian nature.

** Notice of a Reptilian in the Coal of Pictou, by J. W. Dawson, Esq., F.G.S., Journal of Geol. Soc, London. vol. xi, p. 8. Nov. 1854.

†† Notice of a Batrachoid fossil, (*Parabatrachus Colei*) in British Coal shale, by Prof. Owen, F.R.S., &c., Quart. Journ. of Geol. Soc., London, vol. x, p. 207, Dec., 1853. This was first recognised by Prof. McCoy in the Museum of the Earl Enniskiller, also,

Baphetes planiceps, a fossil imbedded in a mass of Pictou Coal from Nova Scotia, by Prof. Owen, F.R.S., &c., Quart. Journ. Geol. Soc., of London, vol. x, p. 207, 1853.

‡‡ Reports on the Geol. Survey, Pennsylvania, not yet published.

§§ Memoirs of Am. Acad. of Arts and Sciences, vol. iii, new series, p. 129.

two genera, not hitherto noticed. Two of the species were discovered by Dr. J. S. Newberry of Ohio, and a third by Mr. C. M. Wheatley of New York, who have entrusted them to me for description.

Raniceps Lyellii.—This was found by Dr. Newberry in company with many other remains, for the most part of fishes, and was regarded by him as Batrachian. He gives the following description of their geological position. "The locality which furnishes the fossil fishes and reptiles is at Linton, Jefferson Co., Ohio, on the property of the Ohio Diamond Coal Co., at the mouth of Yellow Creek. This point is about fifty miles distant from the northwest margin of the Alleghany coal-field, and therefore about as near the centre of the basin as any part of Ohio. The hills bordering the Ohio at the mouth of the Yellow Creek, contain six workable beds of coal, while there are at least two others which lie beneath the bed of the river. Of those exposed, the fourth in the ascending series contains the fishes and reptiles; it is known on Yellow Creek as the "big run" being nearly eight feet in thickness. Of this thickness, the lower four inches is of Cannel coal, and this forms the nidus of our fossils. The "big run" I have traced over several hundred square miles, and there can be no doubt of its position. The animal remains of this deposit lie in immediate proximity to the most characteristic carboniferous plants and shells." Dr. Newberry also gives a section of the different strata, which lie in the following order from above downwards. 1. Shale and sandstone; 2. *coal;* 3. shale and fire-clay; 4. sandstone and shale; 5. *coal;* 6. shale and clay; 7. sand-rock; 8. shale; 9. *coal* with reptilian and fish remains; below this, ten additional strata are mentioned, including three of *coal.* "Geographically, as well as stratigraphically, these fossils come from near the centre of the basin."

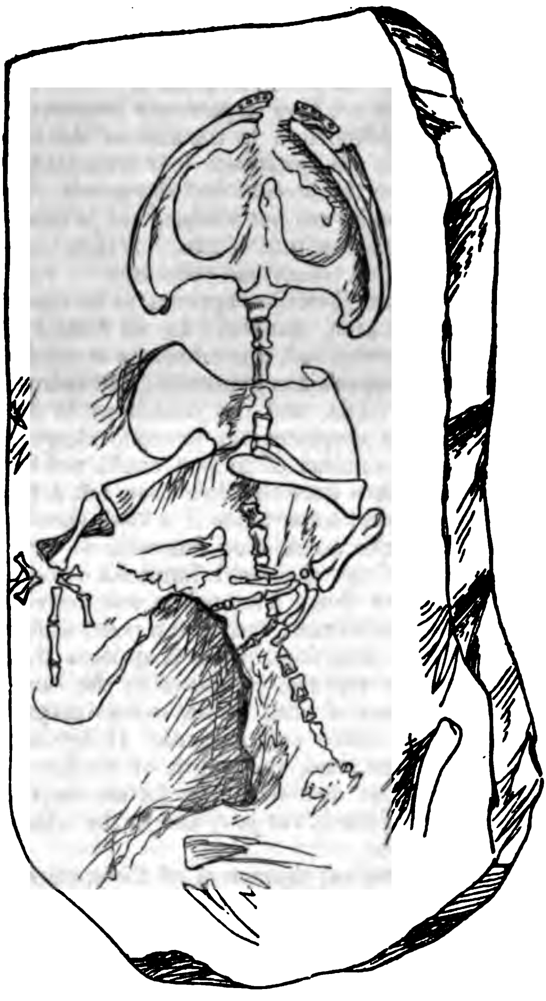
The skeleton (fig. 1,) was exposed on splitting open two laminæ of matrix, and in the act of separation, the tail (if it had one), some of the dorsal vertebræ, and a portion of the pelvis were destroyed. As is usually the case with fossils from the coal, all the bones were very much obscured by compression and by their intimate union with the substance in which they are imbedded. They are seen from the underside and measure about four and one-half inches in length.

The Batrachian characters are strongly marked, and were recognized by Dr. Newberry; yet they do not strictly conform with either one of the two great groups, but rather combine the features of the Urodel and Anourous types; the first predominating in the trunk and extremities, and the latter in the head.

The general form of the head resembles that of frogs; it is triangular, and its greatest breadth nearly equals its length. Existing Urodels are characterised by having the lower jaws either

shorter than the cranium, so that the tympanic bones to which these are articulated are directed obliquely forwards; or as in Menopoma where the jaws are longer, they are directed outwards; in toads, the jaws are as long as the cranium, but in the Ranidæ are decidedly longer and project backwards beyond the occiput, as is also the case with the fossil. In both toads and frogs, the angles of the jaws are slightly concave on their outer surface, but in the fossil no such curve exists, the whole outer border of the jaw being convex as in Urodels generally. The pterygoid bones are less expanded than in Urodels but more so than in Anoura. The dentar bone appears to be closely united with the one behind it, as in Urodels generally and in Pipa among Anoura. The position of the jaw prevents the alveolar margin from being seen; therefore it is impossible to determine either the presence or absence of teeth.

1.



Raniceps Lyellii.

The upper jaws are but imperfectly uncovered, especially on the right side; the two are slightly separated from each other

and are provided with small single pointed teeth. That on the left side is sufficiently exposed to show that it is bifurcated towards the median line, as in Anoura.

The palatine bones could not be traced. The atlas is in close apposition with the occiput so that the articulating surfaces are not visible. The expansion of the atlas indicates however, that two condyles probably exist. No portions of the hyoid bone or of branchial arches were recognized.

The vertebræ are very imperfectly preserved, and are remarkably small in proportion to the size of the animal, and though several of them are destroyed, it is estimated that about twenty existed between the occiput and the pelvis. The transverse processes, if any exist are not visible, nor is there evidence of ribs. The Anoura are destitute of ribs, but these are replaced by very largely developed transverse processes.

A slightly raised outline appears to be the only thing to indicate a scapular arch, but there are no details of structure. The arm is better preserved, the humerus is much contracted in the middle as in Batrachians generally; the radius and ulna are separate as in Urodels, and not united as in Anoura. In consequence of the displacement or concealment of some of the phalanges the number of fingers could not be ascertained with precision. There were certainly four, but a fifth is doubtful. It would be of great importance if a fossil should be detected with five fingers, since no existing Batrachians have more than four, while many of the supposed Batrachian footprints of the coal formations have five. The pelvis was destroyed, but traces of the right and left femur and of the right tibia remain.

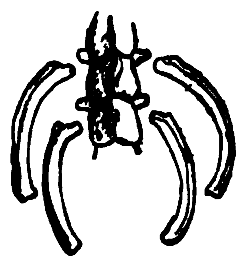
From the above description it appears that this, one of the earliest created reptiles, combines in the same individual some of the characters of both of the two principal groups of Batrachians, viz: Urodels and Anoura. It agrees with the latter in the shape of the head, the length of the lower jaws, and in the absence of ribs; and with the former in the regular convex outer border of the lower jaw, and in the separation of the bones of the fore arm.

If the anatomical characters of the species just described are in any way remarkable, those of the two closely allied ones which remain to be noticed deviate still farther from known forms. One of them was discovered by Mr. Wheatley and the other by Dr. Newberry, in the same locality as the fossil already mentioned in the preceding pages. In both instances about twelve or fifteen dorsal vertebræ and the corresponding ribs are the only parts of the skeleton which are preserved; but as there are only very slight differences in the successive vertebræ and ribs in each specimen, it is probable that several additional ones were necessary to complete the series, and this would indicate

t the animal had a very long and slender body. There are traces whatever of limbs, head or tail, in either case.

Ƭhe specimen, of which a small portion is represented in the ompanying figure (fig. 2, seen from ›ve) is about two and a half inches g. There are in all thirteen or four- n vertebræ with their ribs, these last ng but very slightly displaced. The hes of all but three of the vertebræ broken. The entire vertebra has a ıdrangular form, is a little broader ıind than in front, is surmounted by a nous process forming a longitudinal ge, on each side of which posteriorly, two rather large lobes forming the iculating processes which overlap the succeeding bone. The nsverse processes are well preserved throughout nearly the ole length of the specimen, and are situated near the anterior ıremity of each vertebra, just exterior to the posterior border the articulating processes.

2.



Ƭhe ribs, well developed throughout, are remarkably well pre- ved; each has a short head, and behind this, a well marked ›ercle, showing two points of articulation, and consequently rranting the inference that the transverse processes had like- ɪe two articular facets, though these are not apparent in the sil. The shaft of the rib is very much curved, flattened and ɔressed with a deep groove along its whole length near the ıvex border. The sternal portion of the rib is broader than : centre, as if for the attachment of a cartilage.

Ƭhe general form of the vertebræ presents closer resemblances those of Batrachians than of any other vertebrates, but the ll developed ribs differ very materially from those of any ɔwn Batrachians, viz: in their great length, and the curva- e,—in which respect they resemble those of scaly reptiles. e very existence of ribs separates them from the Anoura, and ɪr length from Urodels; for the first have no ribs and the ond only very short, and for the most part pointed ones.

[f further investigation should prove them to be the remains Batrachians, with which they have some affinities, then we ıll have a type of which there is no living representative. If ɪy belong to a group higher in the series, they become still ›re interesting, and give evidence of the existence in the Coal rmation of animals hitherto referred to later periods.

Ƭhe third specimen consists of a portion of the skeleton of ɔther reptile discovered by Dr. Newberry, closely allied to the ːceding but much larger, and with vertebræ presenting the ne Batrachian features in the ridge-like spinous processes and : broad lobes of the articulating processes, but having also com-

bined with them largely and similarly developed ribs. In this case, the transverse processes if any existed, are not visible, as the vertebral column is turned a little to one side, and thereby one half of them is concealed in the matrix, while, on the other side, the parts are so much broken or covered up by the loose ribs as to prevent examination.

I have given no names to these last two reptiles, notwithstanding their great interest, as their remains were not sufficiently complete to enable me to determine with anything like accuracy their specific or generic characters. To add names to parts of animals, unless the remains are very characteristic, can only serve, as the history of science shows, to impede its progress and encumber it with useless synonyms.

ART. XVI.—*Fichtelite, a fossil carbo-hydrogen found in the "Fichtelgebirge" of North Bavaria;* by T. EDWARDS CLARK, Ph.D.*

THE rare fossil resin, which is the occasion of this paper and which I obtained for analysis through the kindness of Professor Liebig, was collected by Mr. Schmidt, apothecary in Wunsiedel. Near the neighboring town of Redwitz are beds of turf several feet in thickness, which contain large quantities of wood—stems and branches—in various stages of preservation.

The greater portion of this is pine wood, which is so little changed after lying in these turf beds for certainly hundreds of years, that, to all appearance, except that it has become quite dark in color, it does not differ from well dried wood of the same species which is still growing in the vicinity. It cuts and splits the same, burns about as well, and is little inferior in toughness.

Professor Unger,† who has made a microscopic examination of this wood, says that it evidently belongs to the still living species *Pinus sylvestris;* that it is very well preserved, but that in certain parts of the larger vessels a peculiar change has taken place, which has caused the walls of these vessels to lose their coherence and texture.

The other woods found in these turf beds are in a much worse state of preservation. The remains of birches (Betula alba), alders (Alnus glutinosa), and hazlenut (Corylus avellana), are quite numerous. The same species exist at present in the neighborhood. It is in this pine wood, which is still growing so plentifully as to give a name to the mountains of North Bavaria (Fichtelgebirge), that this fossil resin is found. It occurs principally in the form of shining scales between the annual rings,

* A portion of this paper first appeared in the "Annalen der Chemie und Pharmacie" of August, 1857.

† Annalen d. Physik u. Chemie, vol. lix, p. 55.

ιich have separated from one another. The method of ex-
cting it, and its crystalline form we will consider farther on.

In 1837, Trommsdorff* received from Mr. Fikentscher a fossil ιin, which was found, under exactly the same circumstances, the well preserved stems of buried pines. The analysis, ιich he caused to be made, shows, however, that it is the same ɔstance which was found some years later in a brown coal bed ır Utznach in Switzerland, and that it differs both in its com- ʒition and in its melting point, 107° C., from the resin which have analyzed.

In 1841, Bromeis† examined a fossil resin, which was also re- ved from Mr. Fikentscher, and which was found, like the pre- ›us, in the light brown colored pine stems, between the annual gs, often in the form of flat prismatic crystals, colorless and thout taste or smell. It proved however to be quite distinct ım that analyzed by Trommsdorff, both in its composition d in its melting point, 46° C. Bromeis proposed the name ɔhtelite for this.

In 1843, Schrötter‡ became possessed of a fossil resin also ım Redwitz. This was extracted from the wood by ether, d allowed to crystallize, when it was found to be composed of o substances, one of which could not be crystallized, but went wn as an oil. This he considered to be identical in composi- n with Fichtelite; but erroneously, for he overlooked the fact ıt in the analysis by Bromeis the old atomic weight of carbon s used. The crystalline portion of the resin received by hrötter contained oxygen as well as carbon and hydrogen.

From this we see that at least three or four different carbo- drogen fossil resins have been obtained from the turf beds of dwitz; and all have been found in the well preserved stems of s one species of pine tree. But the same has been remarked other places where similar fossil resins have been found.

In the neighborhood of Utznach in Switzerland is a bed of ɔwn coal from two to three feet in thickness, which contains merous remains of pines, firs, birches and other trees, in va- ıus stages of preservation. The pine stems are almost un- anged. This bed of coal has long been considered to belong the Tertiary formation, and is so spoken of by those who have ticed the fossil resins found in it. The remarkable state of ɜservation of the pine wood, and the occurrence of fossil resins it, identical with or very similar to those discovered in the ıe stems of the turf beds of Redwitz, have led me to investi- te more closely the age of this bed of brown coal.

I found that an examination of the plants contained in it has ɔently been made by Professor Heer,§ who has published a

Annalen d. Phar., vol. xxi, p. 126. † Annalen d. Phar., vol. xxxvii, p. 304.
Annalen d. Phys. u. Chem., vol. lix, p. 55.
Neues Jahrbuch für Mineral. u. Geol. v. Leonhard u. Bronn, 1846, p. 218.

fine work on the "Tertiary Flora of Switzerland." He remarks that "the pine which Göppert describes as *Pinites sylvestris*, is evidently the same which we have in our brown coal at Utznach, and which is in every respect not to be distinguished from our living pines. The same is true of the birches and firs. We have found very few animal remains, but these appear to belong to species which still exist with us." Thus showing, as I anticipated, that this brown coal is of the same age as the turf beds of Redwitz.

Stromeyer* was the first to call attention to the existence of a fossil resin found in the wood preserved in this coal bed. To this he gave the name Scheererite.

Later in 1828, Könlein,† who had charge of the working of this bed of coal, described a resin which he had discovered as early as 1822 in the stems of pines occurring in the brown coal. For this, not knowing that Stromeyer had already described a fossil resin from the same bed under the name of Scheererite, he proposed the name of "Naphtaline resineuse prismatique," from its resemblance to naphtaline. Neither Stromeyer nor Könlein gave an analysis of the resin which they described.

In 1829, Macaire Princep‡ analyzed a resin which he, like Stromeyer, had received from Colonel Scheerer, as coming from the brown coal bed of Utznach. Its melting point was found to be but 2 degrees lower than that of Fichtelite. Macaire Princep accepted the name scheererite which Stromeyer had proposed.

Further, in 1838, Krauss§ analyzed a substance which he had obtained from the same locality. This resin in appearance resembled scheererite, but the analysis showed it to be different in composition. In this as well as in the melting point, it does not differ materially from the substance analyzed by Trommsdorff, which was found in the turf beds of Redwitz. Schrötter, who considers the two identical, proposes the name Könlite for them. While scheererite distills undecomposed, könlite yields a substance which melts by the warmth of the hand, and has a composition perhaps identical with that of tekoretin, which we have yet to notice. Krauss proposed the name pyro-scheererite for this latter.

Later, Haidinger‖ in an article comparing the crystalline form of hartite with that of what he supposed to be scheererite, and which he had received from Utznach, remarks that the latter melts at 46° C.

Steenstrup,¶ who has written considerably on the marshes and coal beds of Denmark, discovered in the stems of the pine trees, which are found in these in an almost perfect state of pres-

* Kastner's Archiv., vol. ix, p. 113. † Ann. d. Phys. u. Chem., vol. xii, p. 336.
‡ Ann. d. Phys. u. Chem., xv, p. 294. § Ann. d. Phys. u. Chem., xliii, p. 141.
‖ Ann. d. Phys. u. Chem., vol. liv, p. 261.
¶ Videnskab. Selskabs naturvid. og Math. Afhandlinger. 9 Deel, 1842.

rvation in the neighborhood of Holtegard, a fossil resin which vas supposed to be scheererite. The other woods occurring with this pine (P. sylvestris) are the same as those of Redwitz and Utznach. The resin found by Steenstrup was shown by the analysis of Forchhammer to be composed of two carbo-hydrogens, and both quite distinct from scheererite. They were separated by dissolving in boiling alcohol and allowing to crystallize. Tekoretin, being less soluble than phylloretin, crystallized first. The former melts at 45° C., the latter at 87° C.

From this cursory view of the different carbo-hydrogens discovered in the three localities which have been mentioned, we perceive, that in each place a fossil resin occurs which melts at 45° or 46° C.—viz., Fichtelite described by Bromeis from Redwitz, scheererite (?) by Haidinger from Utznach, and tekoretin by Forchhammer from Holtegard. The relation which they bear to one another, through their actual composition, is noticed beyond.

We have still another locality to mention where a fossil resin is found, from the fact that this fossil, which was analyzed by Schrötter,* was considered by him to be very similar to scheererite and to have the same composition as tekoretin.

In 1841, Haidinger† discovered a fossil resin resembling scheererite in the brown coal beds of Oberhart not far from Vienna. One part of these beds contains numerous stems of a sort of pine tree, which are preserved either as bituminous, or as petrified wood, i. e., quartz in the form of wood. In the different layers and cross breakings of these stems the resin which is called hartite is found. These coal beds have at present an inclination of 70°, and are considered to belong to the tertiary formation. The pine wood in which the resin occurs was examined by Unger‡ and pronounced to belong to the species *Peuce acerosa*, Ug., which is very common in the brown coal formation. Hartite, which was analyzed by Schrötter, melts at 74° C. This is the only carbo-hydrogen fossil found in the coal beds of Oberhart, while at Redwitz there are at least two; at Utznach three have been described, including one derived from the distillation of könlite; and from Holtegard two have been analyzed by Forchhammer.

We have thus briefly alluded to the various fossil resins found in the four different localities mentioned, because it will be necessary to speak of the relation which they bear to one another and to the substance which we have analyzed. As to the actual composition of several of these fossils much doubt exists, for most of the analyses were made at a time when the atomic

* Ann. d. Phys. u. Chem., vol. lix, p. 37.
† Ann. d. Phys. u. Chem., vol. liv, p. 261.
‡ Ann. d. Phys. u. Chem., vol. lix, p. 41.

weight of carbon was considered to be 6·125, and the method of analysis was much less perfect than at present.

We shall now proceed to notice more specially the substance which we have received for analysis. It is found principally between the annual rings of the wood, which have separated or are still loosely joined to one another. Here it forms layers, often one-tenth of an inch in thickness, of shining transparent scales, having more or less of a yellowish tinge, and lapping one over the other. In some parts of the wood are what appear to be minute granules of this resin mixed with woody matter, but when examined under the microscope they prove to be small crystals, with their faces obliquely inclined to one another. I did not succeed in finding any that were large and regular enough for determining the crystalline form.

But this substance is not confined to the annual layers; for if the wood is split in any direction whatever, numerous shining points appear, showing that it is completely saturated with it. In order to obtain this from the wood, the latter is finely cut up with a turning lathe, or by any other convenient means, and then boiled in ether for several hours. The extract is then poured off, fresh ether is added, and again submitted to two or three hours boiling. The two extracts are now poured together and considerably concentrated by distilling off a part of the ether. Strong alcohol is added to this till all remains dissolved.

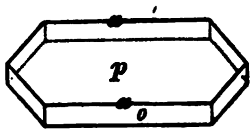
From this it was found impossible to obtain crystals, although exposed to a temperature below 0° C.; a reddish oil went down instead. So in order to separate the resin from other organic bodies, which were presumed to be present, and which were supposed to prevent the forming of crystals, the acetate of lead was added. The large and heavy precipitate, which went down, was thrown on a filter, and the filtrate, after being freed from the excess of acetate of lead by sulphuretted hydrogen, and boiled with the precipitate for a time to decolorize it, was exposed to a cold of a few degrees below 0° C., when long prism-shaped crystals were formed.

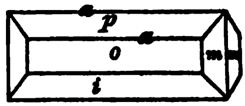
Any foreign substance, or a crystal of this resin thrown into the alcoholic solution, assists the first forming of crystals very materially.

Before cutting up the wood, it is best to scrape off as much resin as possible, for this portion, dissolved in alcohol and ether, crystallizes quite easily.

The precipitate occasioned by the acetate of lead, which is not soluble in ether, was mixed with alcohol and decomposed by a current of sulphuretted hydrogen. In the filtrate of this new precipitate, crystals were formed when exposed to a temperature below 0° C. These we have not yet examined.

The crystals of this resin thus artificially formed are oblique rhombic prisms with orthodiagonal faces. Sometimes an oblique end face is present behind. In the prevailing form the angles of the side faces $m:m=97°$ and $83°$: the end face p to the orthodiagonal face $o=127°$: the second oblique end face behind $i:o=128°$; and $p:i=105°$. The orthodiagonal face cuts off the acute side angle of the prism m. The crystals are lengthened in the direction of the orthodiagonal: m in most very short. If the face p is adjusted in the stauroscope with the sides aa, the cross stands normal; a proof that the crystallization is not triclinic. The measurements could be made only by the reflection of candle light with the use of the lens.





The melting point is 46° C.; but the temperature at which this substance solidifies again is much lower, viz. 36° C., making a difference of ten degrees between the melting and freezing points. These observations were carefully made by experimenting on several different portions of the resin. This somewhat strange behavior has already been observed in other bodies, e. g. oleic acid when melted does not solidify till cooled to 4° C.; its melting point is 14° C.: dœglinic acid, which melts at 16° C., congeals a few degrees above 0° C.

To determine the boiling point of this substance, about five grams were put into a small retort holding a thermometer running up to 320° C. The latter was lowered almost to the surface of the melted resin, and the heat gradually increased till the mercury reached 310°, when the thermometer was taken out, and the retort more strongly heated. Soon, oil drops began to collect in the neck of the latter, which on cooling assumed more or less of a crystalline structure. The distilled portion when dissolved in alcohol and ether crystallized like the original substance, and possessed the same melting and freezing points; showing that it suffered no change by distillation. We may safely say that the boiling point is above 320° C., for the thermometer was rapidly rising when it was taken out. A peculiar but agreeable odor was given out during the distillation, and a small part of the resin was decomposed, accompanied by the separation of coal.

Anhydrous sulphuric acid produces a total decomposition of the substance. A small portion was put into a test tube, and to this the sulphuric acid was added, when, although cold, a violent reaction took place, fumes of sulphurous acid were given out, and the whole tube was blackened with coal.

To another portion Nordhausen acid was added, and then heated in the water-bath. Sulphurous acid was slowly given out, and the solution became deep red. In order to see if any combination with sulphuric acid had taken place, water was added and the whole heated with carbonate of baryta. The precipitate was separated, but the filtrate, which was greatly concentrated by evaporation, yielded no crystals of any soluble salt of baryta.

This experiment was often made in different ways, but without obtaining any combination with sulphuric acid.

To another portion of this resin fuming nitric acid was added, and heated carefully in the water-bath. Soon a violent reaction took place, red fumes of nitrous acid were given out in large quantity. After the action of the nitric acid was finished, the whole was evaporated to one-third its volume, and water added, causing a white precipitate. This was thrown on a filter, washed out, and dissolved in alcohol and ether. The reddish solution was boiled with animal carbon to decolorize it, and then exposed to a temperature several degrees below 0° C. But instead of crystals being formed, an oily substance, which probably holds nitrous acid, was sent down as the ether evaporated. The filtrate of the precipitate caused by the action of water on the nitric acid solution, was evaporated to dryness over the water-bath; the residue was found to contain oxalic acid.

If this resin is thrown into cold fuming nitric acid and allowed to stand for two or three days, it dissolves entirely; but when precipitated from this solution by water, and dissolved in alcohol and ether, it behaves like the last, going down as a reddish oil. A mixture of fuming nitric and sulphuric acids seems to act like nitric acid alone.

Although we have not succeeded in obtaining combinations with nitrous acid, which we know to be such, yet we do not doubt but that they are formed, from the fact that they have been obtained from other substances which are very similar to this.

Chlorine gas in contact with this resin in a melted state combines with it. The experiment is best made by putting a few grams in a small Liebig's drying apparatus, the lower part of which runs horizontally. This is placed in a water-bath, the temperature of which must be kept above 46° C. With this bent tube a retort, in which chlorine gas is generated, is connected. A higher or lower compound of chlorine is formed, in accordance with the length of time that the gas is passed over the melted substance; or two or three compounds may be formed at the same time. Fumes of hydrochloric acid appear at the open end of the tube.

The action of bromine is of course similar to that of chlorine. Hydrobromic acid is given out, and higher or lower compounds are formed, as the quantity of bromine used is greater or less. The substance should be melted in a flask and the bromine added from time to time.

This resin was obtained pure for analysis by several re crystallizations from its solution in alcohol and ether. The combustions were made with chromate of lead, and with rolls of fine oxydized copper wire in the front part of the tube. Three out of several analyses are here given.

I.	0·3324	grm.	of substance gave
	1·0591	"	carbonic acid and
	0·3819	"	water.
II.	0·4314	"	of substance gave
	1·3761	"	carbonic acid and
	0·4960	"	water.
III.	0·4008	"	of substance gave
	1·2859	"	carbonic acid and
	0·4689	"	water.

These give the following percentages:

	I.	II.	III.
Carbon,	86·89	87·00	87·50
Hydrogen,	12·86	12·83	12·99

The average of the three and the corresponding formula are as follows,

	Average.	Calculated.
Carbon,	87·18	C_8 87·27
Hydrogen,	12·86	H_7 12·73

This gives as the empirical formula for this resin C_8H_7. The other analyses confirm this result.

We will now proceed to compare this formula with those obtained by others for several of the fossil resins already mentioned, viz., with Fichtelite analyzed by Bromeis, with hartite analyzed by Schrötter, and with tekoretin and phylloretin analyzed by Forchhammer. But first, we must allude to a matter which has given us no little trouble.

All the above mentioned resins, with the exception of hartite, were analyzed when the atomic weight of carbon was held to be 6·125, hence too much carbon was almost always obtained in an analysis. Now in books on organic chemistry, and in chemical journals when these fossils are alluded to, this fact seems generally to have been overlooked. We will give two or three instances out of the very many which we have noticed.

Schrötter,* who analyzed hartite, compares his results with those obtained by Forchhammer for tekoretin, and remarks that the two substances are very probably identical in composition, and only differ in their melting points. We give the results as obtained by each:

* Ann. d. Phys. u. Chem., vol. lix, p. 44.

	Hartite.	Tekoretin.
Carbon,	87·47	87·19
Hydrogen,	12·04	12·81

Now if we overlook the fact that in the analysis of hartite the atomic weight of carbon was taken as 6, but in the analysis of tekoretin as 6·125, then Schrötter's remark seems to be correct. The actual difference in composition will be seen if we in both cases take the atomic weight of carbon as 6.

Hartite.	Tekoretin.
87·47	85·89
12·04	12·81

Again Gerhardt* commits the same error, but in a different way. On noticing scheererite (könlite) he gives the composition in one hundred parts as obtained by Krauss, who took the atomic weight of carbon as 6·125, but affixes to this a formula in which it is taken as 6: e. g.

		nK^2	H
Carbon,	92·45	92·	8
Hydrogen,	7·42	7·	7

Tekoretin, phylloretin, and other resins are noticed in the same way by Gerhardt. Löwig in his "Organic Chemistry" has many similar errors. The same oversight is also common in works on mineralogy.

Let us now compare the result which we have obtained with the composition of several similar fossil resins. Those analyses which were made when the atomic weight of carbon was held to be 6·125 we have recalculated. The four substances which bear perhaps the nearest relation to that which we have analyzed, are Fichtelite, hartite, tekoretin, and phylloretin. Their composition in one hundred parts is

	Fichtelite.	Hartite.	Tekoretin.	Phylloretin.
C	87·95	87·47	85·89	88·88
H	10·70	12·04	12·81	9·22

They require probably the following formulas: Fichtelite C_5H_4, hartite C_6H_5, tekoretin CH, phylloretin C_3H_2. Though the numbers obtained from the analysis of Fichtelite by Bromeis indicate a different formula, yet we are disposed to consider it identical with the substance which we have analyzed; for they both occur under the same circumstances and in the same peat beds; and moreover they have a common melting point. Fichtelite also distills without being decomposed, and behaves toward alcohol and ether as does this resin.

The difference in composition, indicated by the analyses, may perhaps be accounted for by the fact that Bromeis analyzed Fichtelite just as it was obtained from the wood, without re-

* Traité de Chemie Organique, Tome quatrième, p. 398.

crystallizing it, and hence it was necessarily impure. Rather than increase the confusion already existing in the nomenclature of these and allied substances, we shall adopt the name given by Bromeis.

We should not forget to notice that Trommsdorff has also analyzed a fossil resin coming from Redwitz, and found under the same circumstances, in the stems of *Pinus sylvestris*, and having the same outward appearance as Fichtelite; but in its melting point, 107° C., and in its composition, it differs greatly: viz.

	Könlite (?)
Carbon, - - - - - -	91·05
Hydrogen, - - - - - -	7·57

The formula obtained for hartite stands nearer that of the fossil resin which we have analyzed; its crystals are also monoclinic; towards alcohol, ether, and sulphuric acid it behaves the same; and during distillation but a small portion is decomposed; but its melting point is much higher, 74° C., besides it occurs in another fossil pine, *Peuce acerosa*, Ug., and in another geological formation, being as to its origin much older.

Tekoretin resembles this resin in every particular except in composition. Its melting point is 45° C.; it distills at nearly 336°; possesses the same solubility in alcohol and ether; the effect of nitric acid and chlorine gas is the same, forming two compounds with the latter, which Forchhammer did not succeed in separating; and it is also found in the buried stems of *P. sylvestris;* but the formula required by its analysis obliges us for the present to consider it as another resin.

Phylloretin, which like the latter is found in the pine stems in the marshes of Holtegard, though distilling at a high temperature and forming compounds with chlorine, differs not only in composition, but in its melting point, 87° C., from the fossil resin which we have described.

We have still another carbo-hydrogen resin to notice, which was the first described of all these in 1827. This was called scheererite. It melts at 44° C. and distills, without being decomposed, at 90° C.

Some confusion exists with regard to this fossil, from the fact that Krauss* has given the analysis of a substance under the name of scheererite, which had, it is true, been obtained from the coal beds of Utznach, like that described by Stromeyer and Macaire Princep, but which melts at 107° C.; is decomposed by distillation, and has a composition quite different from scheererite as given by Macaire Princep:

	Scheererite.
Carbon. - - - - - -	71 91
Hydrogen, - - - - - -	24 00

* Ann. d. Phys. u. Chem., vol. xliii, p. 141.

The inexactness of the analysis leaves much doubt as to its true composition. The substance was very volatile, and only one analysis was made. Macaire Princep himself was not satisfied with the result. Since he made the analysis, no substance has been found in the coal beds of Utznach which melts at 44° C. and distills at 90° C.

We give here a table of those fossil resins to which we have referred, together with their melting and boiling points, and also the effect of chlorine, nitric and sulphuric acids on them. We have thought the percentage of carbon and hydrogen found would give a better idea of the relation of these fossils to one another, than their formula, for many of the latter, deduced from the amount of carbon and hydrogen obtained, are doubtful.

	Carbon.	Hydrogen.	Melt'g point.	Boiling point.	Effect of Chlorine.	Of Nitric Acid.	Of sulphuric acid.
Fichtelite by Bromeis,	87·95	10 70	46° C.	Unknown, not decomposed.	unknown	Unknown.	unknown
Fichtelite by Clark,	87·13	12·86	46° C.	Above 320° C.	combines	Oxalic acid, and NO_4 combination (?)	blacken'd
Tekoretin,	85·89	12 81	45° C.	Of quicksilver.	do.	do	unknown
Scheererite by Haidinger,	unknown	unknown	46° C.	Unknown.	unknown	Unknown.	do.
Scheererite by Princep,	71·91	24·00	44° C.	90° C.	do.	do.	blacken'd
Hartite,	87·47	12·04	74° C.	Very high.	do.	do.	do.
Phylloretin,	88·88	9 22	87° C.	Of quicksilver.	combines	Oxalic acid, and NO_4 combination (?)	unknown
Könlite (?) by Trommsdorff,	91·05	7·57	107° C.	Unkn'n, not decomposed	unknown	No effect.	blacken'd
Könlite by Krauss,	91·12	7·421	114° C.	At 200° C., decomposed.	do.	Dissolves it.	do.

The rational formula for any one of the fossils which we have mentioned has not yet been determined. We only know the empirical formula. None of the products resulting from their combination with chlorine, bromine, sulphuric or nitric acids have been analyzed. For this purpose we have formed and analyzed several chlorine and bromine combinations of Fichtelite. Chlorine gas was passed over a few grains of it as already described, for the space of one-half hour. It was then dissolved in alcohol and ether, and stood in the cold to crystallize. After standing several days, all the undecomposed resin crystallized out.

From the mother liquor two combinations with chlorine were obtained, neither of which could be crystallized, though exposed to a cold several degrees below 0° C. The first of these combinations is a clear colorless transparent oil; the other, which is of a yellowish color, we did not obtain in sufficient quanty for analysis.

Over another portion of Fichtelite a stream of chlorine gas was passed for two hours. This was then dissolved in alcohol and ether as the last. Two oils were obtained, neither of which could be crystallized. The one which was first precipitated was

of a deep yellow color and perfectly clear; the other was of a dark red color. There was too little of the latter for analysis.

For determining the amount of chlorine and bromine contained in the oils obtained, the combustions were made with caustic lime. For determining the amount of carbon and hydrogen simply chromate of lead was used, having the combustion tube longer than usual.

Before giving the results obtained, I must remark that it is greatly to be regretted that I did not succeed in obtaining these combinations in a crystalline form; for then there could be no doubt as to their purity. As it is, a small portion of Fichtelite may have been held in solution by the oils, and so of course have affected the results obtained. I therefore present the following analyses with the hope that some one may hereafter be more fortunate than I have been in forming crystalline combinations of this resin with chlorine and bromine.

First chlorine combination.

I. 0·4192 grm. of substance gave
1·1868 " carbonic acid and
0·4216 " water.
II. 0·6903 " of substance gave
0·3156 " chlorid of silver.

Hence

	Calculated.	Found.
C_{30} =	77·555	77·213
H_{38} =	10·987	11·178
Cl_2 =	11·458	11·304

Second chlorine combination.

I. 0·3933 grm. of substance gave
1·0013 " carbonic acid and
0·3448 " water.
II. 0·5411 " of substance gave
0·4432 " chlorid of silver.

Hence

	Calculated.	Found.
C_{30} =	69·783	69·433
H_{63} =	9·595	9·726
Cl_4 =	20·621	20·250

In order to obtain bromine combinations, the resin was acted upon by bromine as previously described, and dissolved in alcohol and ether. After standing several days in the cold most of the time below 0° C. the undecomposed substance had entirely crystallized out. By treating the mother liquor as in the case of the chlorine compounds, two oils were obtained: one of a light red color and perfectly clear, the other dark red and much more consistent.

First bromine combination.

I. 0·4169 grm. of substance gave
1·1646 " carbonic acid and
0·4151 " water.
II. 0·3909 " of substance gave
1·0886 " carbonic acid and
0·3867 " water.

Hence

	Calculated.	Found. I.	Found. II.
C_{80} =	76·315	76·186	75·95
H_{69} =	10·970	11·068	10·99
Br =	12·715	12·751	13·05

Second bromine combination.

0·4828 grm. of substance gave
0·257 " bromid of silver.

Hence

	Calculated.	Found.
C_{80} =	67·801	
H_{68} =	9·605	
Br_{2} =	22·592	22·673

We have thus obtained the four following formulas for the chlorine and bromine compounds:

$C_{80}H_{69}Br_{1}$, $C_{80}H_{68}Br_{2}$, $C_{80}H_{68}Cl_{2}$, $C_{80}H_{66}Cl_{4}$.

Hence the rational formula for Fichtelite would seem to be

	Calculated.	Found.
C_{80} =	87·273	87·13
H_{70} =	12·727	12·86

This is of course quite an unexpected result, although the rational formula for none of these fossil resins has previously been determined. Other carbo-hydrogen substances have however been described with very high formulas, e. g., *Melene* and *Cerene*. The formula for the former is $C_{60}H_{60}$, and for the latter $C_{54}H_{54}$. Moreover both of the substances, like that which we have analyzed, have many of the properties of paraffine, and form compounds with chlorine.

There are two objections to reducing this formula to $C_{40}H_{35}$. The first is that it gives an uneven number of hydrogen atoms, and secondly that in the first bromine compound it requires one-half an atom ($Br_{\frac{1}{2}}$) of bromine. Laurent and others have however expressed half atoms in various formulas.

ART. XVII.—*On the Characters, Principles of Division, and Primary Groups of the Class Mammalia;* by Professor OWEN, F.R.S., F.L.S., Superintendent of the Natural History Departments in the British Museum.*

(Concluded from page 18.)

Primary Divisions of the Mammalia.—The question or problem of the truly natural and equivalent primary groups of the class *Mammalia* has occupied much of my consideration, and has ever been present to my mind when gathering any new facts in the anatomy of the Mammalia, during dissections of the rarer forms which have died at the Zoological Gardens, or on other opportunities.

The peculiar value of the leading modifications of the mammalian brain, in regard to their association with concurrent modifications in other important systems of organs, was illustrated in detail in the Hunterian course of lectures on the Comparative Anatomy of the Nervous System, delivered by me at the Royal College of Surgeons in 1842. The ideas which were broached or suggested during the delivery of that course, I have tested by every subsequent acquisition of anatomical knowledge, and now feel myself justified in submitting to the judgment of the Linnean Society, with a view to publication, the following fourfold primary division of the mammalian class, based upon the four leading modifications of cerebral structure in that class.

The brain is that part of the organization which, by its superior development, distinguishes the Mammalia from all the inferior classes of VERTEBRATA; and it is that organ which I now propose to show to be the one that by its modifications marks the best and most natural primary divisions of the class.

In some mammals the cerebral hemispheres are but feebly and partially connected together by the 'fornix' and 'anterior commissure:' in the rest of the class a part called 'corpus callosum' is added, which completes the connecting or 'commissural' apparatus.

With the absence of this great superadded commissure† is associated a remarkable modification of the mode of development of the offspring, which involves many other modifications; amongst which are the presence of the bones called 'marsupial,' and the non-development of the deciduous body concerned in the nourishment of the progeny before birth, called 'placenta;'

* This paper is cited from the Journal of the Proceedings of the Linnean Society of London. Read February 17th and April 21st, 1857.

† "On the Structure of the Brain in Marsupial Animals," Philos. Trans., 1837, p. 87.

the young in all this 'implacental' division being brought forth prematurely, as compared with the rest of the class.

This first and lowest primary group, or subclass, of Mammalia may be termed, from its cerebral character, *LYENCEPHALA*,*—signifying the comparatively loose or disconnected state of the cerebral hemispheres. The size of these hemispheres (fig. 1, A) is such that they leave exposed the olfactory ganglions (*a*), the cerebellum (C), and more or less of the optic lobes (B); their surface is generally smooth; anfractuosities, when present, are few and simple.

1.—Brain of Opossum.

2.—Brain of Beaver.

The next well-marked stage in the development of the brain is where the corpus callosum (indicated in fig. 2 by the dotted lines *d*, *d*) is present, but connects cerebral hemispheres as little advanced in bulk or outward character as in the preceding subclass; the cerebrum (A) leaving both the olfactory lobes (*a*) and cerebellum (C) exposed, and being commonly smooth, or with few and simple convolutions in a very small proportion, composed of the largest members of the group. The mammals so characterized constitute the subclass *LISSENCEPHALA* † (fig. 2).

In this subclass the testes are either permanently or temporarily concealed in the abdomen: there is a common external genito-urinary aperture in most; two precaval veins ('superior' or 'anterior venæ cavæ') terminate in the right auricle. The squamosal in most, and the tympanic in many, retain their primitive

* λύω, to loose, and ἐγκέφαλος, brain.

† λισσός, smooth, and ἐγκέφαλος, brain.

separation as distinct bones. The orbits have not an entire rim of bone. Besides these more general characters by which the Lissencephala, in common with the Lyencephala, resemble Birds and Reptiles, there are many other remarkable indications of their affinity to the Oviparous Vertebrata in particular orders or genera of the subclass. Such, *e. g.*, are the cloaca, convoluted trachea, supernumerary cervical vertebræ and their floating ribs, in the three-toed Sloth; the irritability of the muscular fibre, and persistence of contractile power in the Sloths and some other Bruta; the long, slender, beak-like edentulous jaws and gizzard of the Anteaters; the imbricated scales of the equally edentulous Pangolins, which have both gizzard and gastric glands like the proventricular ones in birds; the dermal bony armor of the Armadillos like that of loricated Saurians; the quills of the Porcupine and Hedgehog; the proventriculus of the Dormouse and Beaver; the prevalence of disproportionate development of the hind-limbs in the *Rodentia;* coupled, in the Jerboa, with confluence of the three chief metatarsals into one bone, as in birds; the keeled sternum and wings of the Bats; the aptitude of the *Cheiroptera*, *Insectivora*, and certain *Rodentia* to fall, like Reptiles, into a state of true torpidity, associated with a corresponding faculty of the heart to circulate carbonized or black blood:—these, and the like indications of co-affinity with the *Lyencephala* to the oviparous air-breathing Vertebrata, have mainly prevailed with me against an acquiescence in the elevation of different groups of the Lissencephala to a higher place in the Mammalian series, and in their respective association, through some single character, with better-brained orders, according to mammalogical systems which, at different times, have been proposed by zoologists of deserved reputation. Such, *e. g.*, as the association of the long-clawed *Bruta* with the *Ungulata*,* and of the shorter-clawed Shrews, Moles and Hedgehogs, as well as the Bats, with the *Carnivora*;† of the Sloths with the *Quadrumana*;‡ of the Bats of the same high order;§ and of the *Insectivora* and *Rodentia* in immediate sequence after the Linnean 'Primates,' as in the latest published 'System of Mammalogy,' from a distinguished French author.‖

* Macleay, Linn. Trans., vol. xvi (1833); Gray, Dr. J. E., Mammalia in the British Museum, 12mo, 1843, p. xii.

† Cuvier, Règne Animal, 1829, p. 110.

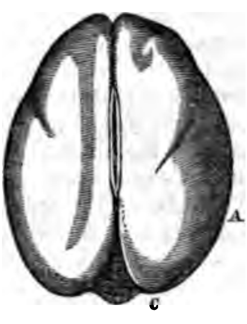
‡ De Blainville, Ostéographie, 4to, fasc. 1, p. 47 (1839).

§ Linnæus, Systema Naturæ.

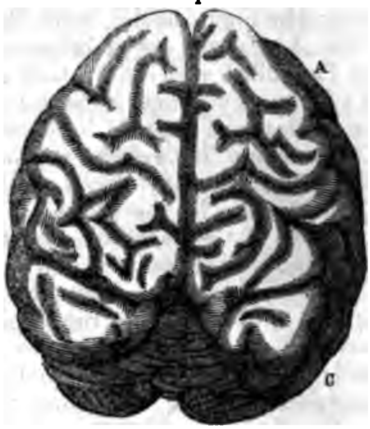
‖ Prof. Gervais, Zoologie et Paléontologie Française, 4to, 1852, p. 194. This scheme is avowedly an adoption of that proposed by Professor Milne-Edwards, in the first volume of the 3rd series of the 'Annales des Sciences Naturelles,' 1844, in a paper entitled 'Considérations sur quelques Principes relatifs à la Classification Naturelle des Animaux,' &c.; in referring to which, M. Gervais states his conviction that Milne-Edwards, "a mis hors de doute les rapports des Rongeurs avec les premiers Mammifères."—Annales des Sciences Naturelles, ser. iii, vol. i, p. 251. The

The third leading modification of the Mammalian cerebrum is such an increase in its relative size, that it extends over more or less of the cerebellum; and generally more or less over the olfactory lobes. Save in very few exceptional cases of the smaller and inferior forms of *Quadrumana* (fig. 3), the superficies is folded into more or less numerous gyri or convolutions,—whence the name *GYRENCEPHALA*,* which I propose for the third subclass of Mammalia (fig. 4).

3.



4.—Chimpanzee.



In this subclass we shall look in vain for those marks of affinity to the *Ovipara*, which have been instanced in the preceding subclasses. The testes are, indeed, concealed, and through an

high and justly-earned reputation of both these naturalists renders it incumbent on me to state the doubts with respect to the actual affinity of the Rodentia to the Quadrumana which remained on my mind after an attentive perusal of the arguments urged by Milne-Edwards. The first of these arguments is based upon an alleged resemblance of placental structure, expressed by the term "à placenta discoide," applied as a character to the Bimana, Quadrumana, Cheiroptera, Insectivora and Rodentia, collectively.

The degree of resemblance in outward form, between the placenta of the Rat or Hare, on the one hand, and the *Mycetes* and *Macacus* on the other, seems to me to be more than counterbalanced by the difference of structure. The pedunculate and cotyloid placenta of the Rat consists of fœtal parts exclusively; the maternal areolar portion is as distinct from it as it is in the cotyledon of the Ruminant, and is a persistent structure of the uterus. The discoid placenta of the Monkey includes a large proportion of maternal cellular structure, which comes away with the fœtal portion. The difference in the organic interblending of the circulatory organs of mother and offspring, between the *Rodentia* and *Quadrumana*, is of much more real importance than the degree of superficial similarity. Still more significant, in regard to genetic grounds of affinity, is the great difference in the development and function of the vitellicle or umbilical sac in the fœtal membranes of the two orders. But, as regards outward form, the cotyloid placenta of the *Murida* differs more from the thin, expanded and subdivided placenta of the Hare, than it does from that of the Marmoset Monkey: then, it signifies something in the argument drawn

* γυρόω, to bend or wind, and ἐγκέφαλος, brain.

rious adaptive principle, in the Cetacea; but in the rest of the class, with the exception of the Elephants, they pass out of abdomen, and the Gyrencephalous quadrupeds, as a general e, have a scrotum. The vulva is externally distinct from the is. With the exception, again, of the Elephants, the blood m the head and anterior limbs is returned to the right auricle a single precaval trunk. The mammalian modification of the rtebrate type attains its highest physical perfections in the *rencephala*, as manifested by the bulk of some, by the destruc- mastery of others, by the address and agility of a third er. And, through the superior psychological faculties—an

1 similarity of form, that there are two distinct discoid placenta in *Callithrix* as *'ercopithecus, Macacus* and *Semnopithecus;* whilst in *Mycetes*, as in *Troglodytes*, e is but one such placenta.

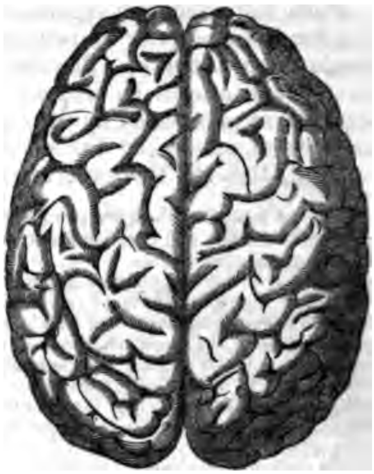
he structure of the discoid placenta in the *Pteropus*, like that of the Rat, more mbles that of the fœtal portion of the cotyledon in the Cow than that of the ılo-vascular spongy placenta of the *Quadrumana;* and this difference, with the e important one of the larger umbilical sac, appears to me to greatly outweigh degree of resemblance in mere outward form of the placenta. Any argument ıvor of the affinity of the *Cheiroptera* to the *Quadrumana*, based on that degree esemblance, must be affected by the prevalence of the double discoid placenta ıe *Quadrumana*. Since Hunter first made known that modification* in a species *Macacus*, which, from a comparison of the fœtus now preserved in the Museum he Royal College of Surgeons, I believe to be the 'Wrinkled Baboon' of Shaw *ıcacus rhesus*, Desm.), Professor Breschet has described and figured the two sep- e discoid placentæ in the small South American Squirrel-monkey (*Callithrix reus*, Kuhl), in the Green Monkey (*Cercopithecus sabæus*, Desm.), and in the g-nosed Monkey (*Semnopithecus nasicus*). Yet this well-marked modification of cellulo-vascular placenta is not constant in the *Quadrumana*, or even in the pri- y groups of the order. In the Platyrhines, *e.g.*, the Howler (*Mycetes seniculus*, ıl) has a single placenta; and amongst the Catarhines, I have ascertained that, in Chimpanzee (*Troglodytes niger*) the placenta is single, as in the Human subject. he five flat placental lobes, virtually as distinct as if they were separate pla- æ, in the Hare, resemble more the subdivided placentæ of the Sloth than the le hemispheroid pedunculate placenta of the Rat, or the flattened circular pla- a of the Howler Monkey. In short, the observed differences of form in the pla- æ of the *Rodentia, Insectivora, Cheiroptera* and *Quadrumana* by no means justify use of one general term as applicable to the whole.†

he second argument for the association of the *Insectivora, Cheiroptera* and *Roden-* with the *Quadrumana* is taken from alleged conformity of cerebral structure. Le cerveau d'un Rongeur diffère à peine de celui d'un Insectivore; il existe aussi resemblance extrême entre l'encephale d'un Insectivore et celui de certains ıdrumanes;" whence it is meant to be inferred, that there is the same extreme mblance between the brain in *Rodentia* and certain *Quadrumana*. In my paper he 'Brains of the Marsupialia,' (Phil. Trans., 1837,) I have described and figured v, p. 93) the brain of a Beaver (see fig. 2, p. 178) and that of a small Monkey *das rufimanus*, fig. 3, p. 180), showing the absence of cerebral convolutions in h. As the cerebral hemispheres have since been shown to be equally smooth in er *Hapalidæ* of Isodore Geoffroy, in the Potto Lemur‡ (*Perodicticus*, Bennett), *Microcebus*§, and with few and feeble traces of convolutions in *Stenops tardigra-* (Vrolik, d'Anatomie comparée sur le genre *Stenops*, in N. Verhand. der 1ste sse Koninkl. Nederl. Inst. Amsterdam, Oct. 1848), there is, to that extent, in Quadrumanous order, a superficial resemblance to the non-convoluted brains of *Rodentia* and *Insectivora;* but it is attended by that more important difference

* Animal Economy, 4to, 1780. † Annales des Sciences Nat., tom. cit., p. 96.
‡ Bijdrage tot de Kennis van den Potto van Bosman, 4to, 1851, V. der Hoeven.
§ Comptes Rendus de l'Acad. des Sciences, Janiver 19, 1852.

adaptive intelligence predominating over blind instinct—which are associated with the higher development of the brain, the *Gyrencephala* afford those species which have ever formed the most cherished companions and servitors, and the most valuable sources of wealth and power, to mankind.

5.—Negro.



In Man the brain presents an ascensive step in development, higher and more strongly marked than that by which the preceding subclass was distinguished from the one below it. Not only do the cerebral hemispheres (figs. 5 and 6, A) overlap the olfactory lobes and cerebellum, but they extend in advance of the one, and farther back than the other (fig. 6, C). Their posterior development is so marked, that anatomists have assigned to that part the character of a third lobe; it is peculiar to the genus *Homo*, and equally peculiar is the 'posterior horn of the lateral ventricle,' and the 'hippocampus minor,' which charac-

6.—Side view, Negro.

in the form and proportions of the cerebral hemispheres, of which I express my estimate by the system of Classification proposed in the present paper.

The smooth hemispheres of the brain of the *Midas* (fig. 3, A) "extend, as in most of the *Quadrumana*, over the greater part of the cerebellum (C)," (Phil. Trans., 1837, p. 93); it resembles, in short, the brain of the Human embryo before the cerebral surface begins to be folded; whereas in the *Insectivora*, in the Beaver, and even in the Capybara, in which there are a few shallow anfractuosities, the cerebral hemispheres leave the cerebellum quite exposed.

With regard to the alleged contrast between the brains of the *Rodentia* and *Carnivora*, in the breadth of the anterior and middle part of the cerebral hemispheres, a comparison of the brains of the Beaver and Coatimondi, and of the Porcupine and the Civet Cat, leaves me entirely unable to appreciate the force of the remark.

The third argument for the high position of the *Rodentia*, *Cheiroptera* and *Insectivora* in the Mammalian scale, is deduced from some particulars of their osteology,

erize the hind lobe of each hemisphere. The superficial grey natter of the cerebrum, through the number and depth of the onvolutions, attains its maximum of extent in Man.

Peculiar mental powers are associated with this highest form f brain, and their consequences wonderfully illustrate the value f the cerebral character; according to my estimate of which, I m led to regard the genus *Homo*, as not merely a representative f a distinct order, but of a distinct subclass of the Mammalia,* or which I propose the name of '*ARCHENCEPHALA*'† (fig. 6).

With this preliminary definition of the organic characters, which appear to guide to a conception of the most natural prinary groups of the class *Mammalia*, I next proceed to define he groups of secondary importance, or the subdivisions of the oregoing subclasses.

In the Lyencephalous Mammalia some have the 'optic lobes' imple, others partly subdivided, or complicated by accessory anglions, whence they are called 'bigeminal bodies.' The Lyncephala with simple optic lobes are 'edentulous' or without alcified teeth, are devoid of external ears, scrotum, nipples, and narsupial pouch: they are the true 'testiconda;' they have a oracoid bone extending from the scapula to the sternum, and lso an epicoracoid and episternum, as in Lizards; they are unguiculate and pentadactyle, with a supplementary tarsal bone upporting a perforated spur in the male. The order so charac-

nd principally from the common presence of the clavicle in them, as contrasted vith its constant absence in the *Carnivora* and *Ungulata*. The clavicle is present n all *Quadrumana*, but it is not a peculiar characteristic of the higher forms of the Mammalian class. It is much more constant in the class of Birds and Reptiles: it s present in the *Monotremes*, in *Marsupials*, and in most *Bruta*. An affinity of the *nsectivora* and of the claviculate *Rodentia* with a lower vertebrate type, might herefore be inferred from the clavicle, at least with as much reason, as with Apes nd Man. As to the shape of the articular cavity for the mandible, the *Rodentia* iffer more from the *Quadrumana* in this particular than the *Carnivora* do; whilst, n respect of the size, form, and persistent individuality of the tympanic bone, the *Rodentia* plainly show their more essential relations to the oviparous type; the *Carnivora* resembling the *Quadrumana* in the early coalescence of the petro-tympanic with the squamosal elements of the temporal bone.

Such are some of the considerations which have induced me to set a different alue than M. Gervais does, on the arguments adduced by Prof. Milne-Edwards in avor of the association of the *Rodentia* with the *Quadrumana*, in a highly placed rimary group of the Mammalian class.

* Not being able to appreciate, or conceive of the distinction between the psychcal phenomena of a Chimpanzee and of a Boschisman, or of an Aztec with arrested rain-growth, as being of a nature so essential as to preclude a comparison between hem, or as being other than a difference of degree, I cannot shut my eyes to the ignificance of that all-pervading similitude of structure—every tooth, every bone, trictly homologous,—which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty. And, therefore, with every respect or the author of the "Records of Creation," (8vo, 1816, pp. 13-21,) I follow Linæus and Cuvier in regarding man as a legitimate subject of zoological comparison nd classification.

† ἄρχω, to overrule, and ἐγκέφαλος, brain.

terized is called 'MONOTREMATA,' in reference to the single excretory and generative outlet, which, however, is by no means peculiar to them among Mammalia. The Monotremes are insectivorous, and are strictly limited to Australia and Tasmania.

The MARSUPIALIA are Mammals distinguished by a peculiar pouch or duplicature of the abdominal integument, which in the males is everted, forming a pendulous bag containing the testes; and in the females is inverted, forming a hidden pouch containing the nipples and usually sheltering the young for a certain period after their birth: they have the marsupial bones in common with the Monotremes; a much-varied dentition, especially as regards the number of incisors, but usually including 4 true molars; and never more than 3 premolars:* the angle of the lower jaw is more or less inverted.†

With the exception of one genus, *Didelphys*, which is American, and another genus, *Cuscus*, which is Malayan, all the known existing Marsupials belong to Australia, Tasmania, and New Guinea. The grazing and browsing Kangaroos are rarely seen abroad in full daylight, save in dark rainy weather. Most of the Marsupialia are nocturnal. Zoological wanderers in Australia, viewing its plains and scanning its scrubs by broad daylight, are struck by the seeming absence of mammalian life; but during the brief twilight and dawn, or by the light of the moon, numerous forms are seen to emerge from their hiding-places and illustrate the variety of marsupial life with which many parts of the continent abound. We may associate with their low position in the mammalian scale the prevalent habit amongst the Marsupialia of limiting the exercise of the faculties of active life to the period when they are shielded by the obscurity of night.

The Lissencephala or smooth-brained Placentals form a group which I consider as equivalent to the Lyencephala or Implacentals; and which includes the following orders *Rodentia*, *Insectivora*, *Cheiroptera* and *Bruta*. The RODENTIA are characterized by two large and long curved incisors in each jaw, separated by a wide interval from the molars; and these teeth are so constructed, and the jaw is so articulated, as to serve in the reduction of the food to small particles by acts of rapid and continued gnawing, whence the name of the order. The orbits are not separated from the temporal fossæ. The testes pass periodically from the abdomen into a temporary scrotum, and are associated with prostatic and vesicular glands. The placenta is commonly discoid, but it is sometimes a circular mass (Cavy), or flattened and divided into three or more lobes (Lepus). The Beaver and

* "Outlines of a Classification of the Marsupialia," Trans. Zool. Soc., vol. ii, 1839.

† For other Osteological and Dental characteristics of the Marsupialia, see the paper above cited, and that "On the Osteology of the Marsupialia," Trans. Zool. Soc., vol. ii, p. 379 (1838).

Capybara are now the giants of the order, which chiefly consists of small, numerous, prolific and diversified unguiculate genera, subsisting wholly or in part on vegetable food. Some Rodents, *e. g.* the Leamings, perform remarkable migrations, the impulse to which, unchecked by danger or any surmountable obstacles, seems to be mechanical. Many Rodents build very artificial nests, and a few manifest their constructive instinct in association. In all these inferior psychical manifestations we are reminded of Birds. Many Rodents hibernate like Reptiles. They are distributed over all continents.

The transition from the Marsupials to the Rodents is made by the Wombats; and the transition from the Marsupials is made, by an equally easy step, through the smaller Opossums to the INSECTIVORA. This term is given to the order of small smooth-brained Mammals, the molar teeth of which are bristled with cusps, and are associated with canines and incisors: they are unguiculate, plantigrade, and pentadactyle, and they have complete clavicles. The testes pass periodically from the abdomen into a temporary scrotum, and are associated with large prostatic and vesicular glands: like most other *Lissencephala*, the Insectivora have a discoid or cup-shaped placenta. Their place and office in South America and Australia are fulfilled by Marsupialia; but true Insectivora exist in all the other continents.

The order CHEIROPTERA, with the exception of the modification of their digits for supporting the large webs that serve as wings, repeat the chief characters of the Insectivora; but a few of the larger species are frugivorous, and have corresponding modifications of the teeth and stomach. The mammæ are pectoral in position, and the penis is pendulous in all Cheiroptera. The most remarkable examples of periodically torpid Mammals are to be found in the terrestrial and volant Insectivora. The frugivorous Bats differ much in dentition from the true Cheiroptera, and would seem to conduct through the Colugos or Flying Lemurs, directly to the Quadrumanous order. The Cheiroptera are cosmopolitan.

The order BRUTA, called *Edentata* by Cuvier, includes two genera which are devoid of teeth; the rest possess those organs, which, however, have no true enamel, are never displaced by a second series, and are very rarely implanted in the premaxillary bones. All the species have very long and strong claws. The ischium as well as the ilium unites with the sacrum; the orbit is not divided from the temporal fossa. I have already adverted to the illustration of affinity to the oviparous Vertebrata which the Three-toed Sloths afford by the supernumerary cervical vertebræ supporting false ribs and by the convolution of the windpipe in the thorax; and I may add that the unusual number—three and

twenty pairs—of ribs, forming a very long dorsal, with a short lumbar, region of the spine in the Two-toed Sloth, recalls a lacertine structure. The same tendency to an inferior type is shown by the abdominal testes, the single cloacal outlet, the low cerebral development, the absence of medullary canals in the long bones in the Sloths, and by the great tenacity of life and long-enduring irritability of the muscular fibre, in both the Sloths and Ant-eaters.*

The order Bruta is but scantily represented at the present period. One genus *Manis* or Pangolin, is common to Asia and Africa; the *Orycteropus* is peculiar to South Africa; the rest of the order, consisting of the genera *Myrmecophaga*, or true Ant-eaters, *Dasypus* or Armadillos, and *Bradypus* or Sloths, are confined to South America.

Having defined the orders or subdivisions of the two foregoing subclasses, I may remark that the Lyencephala cannot be regarded as equivalent merely to one of the orders, say *Rodentia*, of the Lissencephala, without undervaluing the anatomical characters which are so remarkable and distinct in the marsupial and monotrematous animals. The anatomical peculiarities of the edentulous Lyencephala† appear to me to be, at least, of ordinal importance. In these deductions I hold the mean between those who, with Geoffroy St. Hilaire, would make of the *Monotremata* a distinct class of animals, or with De Blainville, a distinct subclass (*Ornithodelphes*) of Mammals,‡ and those who, with Cuvier, would make the Monotremes a mere family of the *Edentata*, or, with Mr. Waterhouse, a family of the *Marsupiata*.§ In like manner, whilst I regard the Lyencephala (*Marsupiata* of Waterhouse) as forming a group of higher rank than an order, I do not consider it as forming an equivalent primary group to that formed by all the placental Mammalia.

It appears to me that the true value of the Lyencephala or Implacentalia is that of one of four primary divisions or subclasses of the Mammalia; that its true equivalency is with the Lissencephala, and that all its analogical relations are to be found more truly in that smooth-brained subclass than in the Placentalia at large.

* This latter vital character attracted the notice of the earliest observers of these animals. Thus Marcgrave and Piso narrate of the Sloth:—"Cor motum suum validissimè retinebat, postquam exemptum erat e corpore per semihorium:—exempto corde cæteris visceribus, multò post se movebat et pedes lentè contrahebat sicut dormituriens solet.' Buffon, who quotes the above from the 'Historia Naturalis Brasiliæ,' p. 322, well remarks, "Par ces rapports, ce quadrupède se rapproche non seulement de la tortue, dont il a la lenteur, mais encore des autres reptiles et de tous ceux qui n'ont pas un centre du sentiment unique et bien distinct."—Hist. Naturelle, 4to, tom. xiii, p. 45.

† See my article *Monotremata*, in the Cyclopædia of Anatomy, part xxvi, 1841.

‡ Ostéographie, fascicule premier, 4to, 1839, p. 47.

§ Nat. Hist. of Mammalia, part i, 1845, p. 18.

The following table exemplifies the correspondence of the groups in the Lyencephalous and Lissencephalous series:—

LYENCEPHALA.	LISSENCEPHALA.
*Rhizophaga**	Burrowing *Rodentia.*
*Poëphaga**	*Dipodidæ* and *Leporidæ.*
Petaurus	*Pteromys.*
Phalangistidæ	*Sciuridæ* and prehensile-tailed arboreal Rodents.
Phascolarctos	*Bradypus.*
Perameles and *Mymecobius*	*Erinaceidæ.*
Chæropus	*Macroscelis.*
Didelphys and *Phascogale*	*Soricidæ.*
Dasyuridæ	*Centetes*, *Gymnura.*
Echidna	*Manis.*
Ornithorhyncus	*Orycteropus.*

The classification proposed by M. Gervais, already cited (p. 179), in which the *Rodentia*, *Cheiroptera*, and *Insectivora* are associated in the same high primary group with the *Quadrumana* and *Bimana*, is avowedly adopted from that previously proposed by Prof. Milne Edwards.†

In next proceeding to consider the subdivisions of the Gyrencephala, we seem at first to descend in the scale in meeting with a group of animals in that subclass, having the form of fishes; but a high grade of mammalian organization is masked beneath this form. The Gyrencephala are primarily subdivided, according to modifications of the locomotive organs, into three series, for which the Linnean terms may well be retained; viz. *Mutilata*, *Ungulata* and *Unguiculata*, the maimed, the hoofed, and the clawed series.

These characters can only be applied to the Gyrencephalous subclass; *i. e.* they do not indicate natural groups, save in that section of the Mammalia. To associate the Lyencephala and Lissencephala with the unguiculate Gyrencephala into one great primary group, as in the Mammalian systems of Ray, Linnæus and Cuvier, is a misapplication of a solitary character akin to that which would have founded a primary division on the discoid placenta or the diphyodont dentition. No one has proposed to associate the unguiculate Bird or Lizard with the unguiculate Ape, and it is but a little less violation of natural affinities to associate the Monotremes with the Qaudrumanes in the same primary (unguiculate) division of the Mammalian class.

* See the "Classification of the Marsupialia," in the Zoological Transactions, vol. ii. p. 232.

† See note at p. 179.

The three primary divisions of the Gyrencephala are of higher value than the ordinal divisions of the Lissencephala; just as those orders are of higher value than the representative families of the Marsupials.

The *Mutilata*, or the maimed Mammals with folded brains, are so called because their hind-limbs seem, as it were, to have been amputated; they possess only the pectoral pair of limbs, and these in the form of fins: the hind end of the trunk expands into a broad, horizontally flattened, caudal fin. They have large brains with many and deep convolutions, and are naked, and have neither neck, scrotum, nor external ears.

The first order, called CETACEA, in this division are either edentulous or monophyodont, and with teeth of one kind and usually of simple form. They are testicond and have no 'vesiculæ seminales.' The mammæ are pudendal; the placenta is diffused; the external nostrils—single or double—are on the top of the head, and called spiracles or "blow-holes." They are marine, and, for the most part, range the unfathomable ocean; though with certain geographical limits as respects species. They feed on fishes or marine animals.

The second order, called SIRENIA, have teeth of different kinds, incisors which are preceded by milk-teeth, and molars with flattened or ridged crowns, adapted for vegetable food. The nostrils are two, situated at the upper part of the snout; the lips are beset with stiff bristles; the mammæ are pectoral; the testes are abdominal, as in the Cetacea, but are associated with vesiculæ seminales. The Sirenia exist near coasts or ascend large rivers, browsing on fuci, water plants or the grass of the shore. There is much in the organization of this order that indicates its affinity to members of the succeeding division.

In the *Ungulata* the four limbs are present, but that portion of the toe which touches the ground is incased in a hoof, which blunts its sensibility and deprives the foot of prehensile power. With the limbs restricted to support and locomotion, the Ungulata have no clavicles: the fore-leg remains constantly in the state of pronation, and they feed on vegetables.

A particular order, or suborder, of this group is indicated by certain South American genera, *e. g. Toxodon* and *Nesodon*,* with long, curved, rootless teeth, having a partial investment of enamel, and with certain peculiarities of cranial structure: the name TOXODONTIA is proposed for this order, all the representatives of which are extinct.

A second remarkable order, most of the members of which have, also, passed away, is characterized by two incisors in the form of long tusks; in one genus (*Dinotherium*) projecting from

* Philosophical Transactions, 1853, p. 291.

under jaw, in another genus (*Elephas*) from the upper jaw, l in some of the species of a third genus (*Mastodon*), from th jaws. There are no canines; the molars are few, large and nsversely ridged; the ridges sometimes few and mammillate, en numerous and with every intermediate gradation. The se is prolonged into a cylindrical trunk, flexible in all direcns, highly sensitive, and terminated by a prehensile append- like a finger: on this organ is founded the name PROBOSIA given to the order. The feet are pentadactyle, but are licated only by divisions of the hoof; the testes are abdominal; placenta is annular;* the mammæ are pectoral.

Both the present and preceding orders of *Ungulata* may be led aberrant: the dentition of the Toxodon, and several parulars of the organization of the Elephant, indicate an affinity the Rodentia; the cranium of the Toxodon, like that of the nothere, resembles that of the Sirenia in its remarkable moditions.

The typical Ungulate quadrupeds are divided, according to odd or even number of the toes, into PERISSODACTYLA and TIODACTYLA.† In the perissodactyle or odd-toed Ungulata— d-toed at least in regard to the hind-foot,—the dorso-lumbar rtebræ differ in number in different species, but are never ver than twenty-two; the femur has a third trochanter; and medullary artery does not penetrate the fore-part of its shaft. e fore-part of the astragalus is divided into two very unequal ets. The os magnum and the digitus medius which it suprts are large, in some disproportionately so, and the digit is nmetrical: the same applies to the ectocuneiform and the ;it which it supports in the hind-foot. If the species be rned, the horn is single; or, if there be two, they are placed the median line of the head, one behind the other, each being as an odd horn. The nasals expand posteriorly. There is a ll-developed post-tympanic process which is separated by the e mastoid from the paroccipital in the Horse, but unites with lower part of the paroccipital in the Tapir, and seems to ce the place of the mastoid in the Rhinoceros and Hyrax. e hinder half, or a larger proportion, of the palatines enters o the formation of the posterior nares, the oblique aperture of ich commences in advance either of the last molar, or, as in st, of the penultimate one. The pterygoid process has a broad d thick base, and is perforated lengthwise by the ectocarotid. e crown of from one to three of the hinder premolars is as

* Besides the annular placenta there is a subcircular villous patch at each pole of chorionic bag, by which it derived additional attachment to the uterus, in the phant.

† From περισσοδάκτυλος, qui digitos habet impares numero; and ἄρτιος, par τυλος, digitus.

complex as those of the molars:* that of the last lower milk-molar is commonly bilobed. To these osteological and dental characters may be added some important modifications of internal structure, as, *e. g.* the simple form of the stomach and the capacious and sacculated cæcum, which equally evince the mutual affinities of the odd-toed or perissodactyle hoofed quadrupeds, and their claims to be regarded as a natural group of the *Ungulata.* The placenta is replaced by a diffused vascular villosity of the chorion in all the recent genera of this order, excepting the little *Hyrax,* in which there is a localised annular placenta, as in the Elephant. But the diffused placenta occurs in some genera of the next group, showing the inapplicability of that character to exact classification. Many extinct genera, *e. g. Coryphodon, Pliolophus, Lophiodon, Tapirotherium, Palæotherium, Ancitherium, Hipparion, Acerotherium, Elasmotherium, &c.,* have been discovered, which once linked together the now broken series of Perissodactyles, represented by the existing genera *Rhinoceros, Hyrax, Tapirus,* and *Equus.*

In the even-toed or 'artiodactyle' Ungulates, the number of the dorso-lumbar vertebræ is the same, as a general rule, in all the species, being nineteen. The recognition of this important character appears to have been impeded by the variable number of moveable ribs in different species of the Artiodactyles, the dorsal vertebræ, which those ribs characterize, being fifteen in the Hippopotamus and twelve in the Camel. And the value of this distinction has been exaggerated owing to the common conception of the ribs as special bones distinct from the vertebræ, and their non-recognition as parts of a vertebra equivalent to the neurapophyses and other autogenous elements. The vertebral formulæ of the Artiodactyle skeletons show that the difference in the number of the so-called dorsal and lumbar vertebræ does not affect the number of the entire dorso-lumbar series: thus, the Indian Wild Boar has *d.* 13, *l.* 6=19; the Domestic Hog and the Peccari have *d.* 14, *l.* 5=19; the Hippopotamus has *d.* 15, *l.* 4=19; the Gnu and Aurochs have *d.* 14, *l.* 5=19; the Ox and most of the true Ruminants have *d.* 13, *l.* 6=19; the aberrant Ruminants have *d.* 12, *l.* 7=19. The natural character and true affinities of the Artiodactyle group are further illustrated by the absence of the third trochanter in the femur, and by the place of perforation of the medullary artery at the fore and upper part of the shaft, as in the Hippopotamus, the Hog, and most of the Ruminants. The fore part of the astragalus is divided into two equal or sub-equal facets: the os magnum does not exceed, or is less than, the unciforme in size, in the carpus; and the ectocuneiform is less, or not larger, than the cuboid, in the tarsus.

* The extinct Lophiodonts form the sole known exception to this rule.

The digit answering to the third in the pentadactyle foot is unsymmetrical, and forms, with that answering to the fourth, a symmetrical pair. If the species be horned, the horns form one pair or two pairs; they are never developed singly, of symmetrical form, from the median line. The post-tympanic does not project downward distinctly from the mastoid, nor surpersede it in any Artiodactyle; and the paroccipital always exceeds both those processes in length. The bony palate extends farther back than in the Perissodactyles; the hinder aperture of the nasal passages is more vertical and commences posterior to the last molar tooth. The base of the pterygoid process is not perforated by the ectocarotid artery. The crowns of the premolars are smaller and less complex than those of the true molars, usually representing half of such crown. The last milk-molar is trilobed.

To these osteological and dental characters may be added some important modifications of internal structure, as, *e. g.* the complex form of the stomach in the Hippopotamus, Peccari, and Ruminants; the comparatively small and simple cæcum and the spirally folded colon in all Artiodactyles, which equally indicate the mutual affinities of the even-toed hoofed quadrupeds, and their claims to be regarded as a natural group of the *Ungulata.* The placenta is diffused in the Camel-tribe and non-ruminants; is cotyledonal in the true Ruminants. Many extinct genera, *e. g. Chæropotamus, Anthracotherium, Hyopotamus, Entelodon, Dichodon, Merycopotamus, Xiphodon, Dichobune, Anoplotherium, Microtherium,* &c., have been discovered, which once linked together the now broken series of Artiodactyles, represented by the existing genera, *Hippopotamus, Sus, Dicotyles, Camelus, Auchenia, Moschus, Camelopardalis, Cervus, Antilope, Ovis,* and *Bos.*

A well-marked, and at the present day, very extensive subordinate group of the Artiodactyles, is called *Ruminantia,* in reference to the second mastication to which the food is subject after having been swallowed; the act of rumination requiring a peculiarly complicated form of stomach. The Ruminants have the 'cloven foot,' *i. e.* two-hoofed digits on each foot forming a symmetrical pair, as by the cleavage of a single hoof; in most species two small supplementary hoofed toes are added. The metacarpals of the two functional toes coalesce to form a single 'cannon-bone,' as do the corresponding metatarsals. The Camel-tribe have the upper incisors reduced to a single pair; in the rest of the Ruminants the upper incisors are replaced by a callous pad. The lower canines are contiguous, and, save, in the Camel-tribe, similar to the six lower incisors, forming part of the same terminal series of eight teeth, between which and the molar series there is a wide interval. The true molars have their grinding surface marked by two double crescents, the convexity

of which is turned inwards in the upper and outwards in the under jaw.

Many fossil Artiodactyles, with similar molars, appear to have differed from the Ruminants chiefly by retaining structures which are transitory and embryonic in most existing Ruminants, as, *e. g.*, upper incisors and canines,* first premolars, and separate metacarpal and metatarsal bones; these are among the lost links that once connected more intimately the Ruminants with the Hog and Hippopotamus.

The Pachyderms in the Cuvierian system included all the non-ruminant hoofed beasts; they were divided by the great French anatomist into the *Proboscidia*, *Solidungula*, and *Pachydermata ordinaria*, the latter again being subdivided according to the odd or even number of the hoofs. I have on another occasion† adduced evidence to show that the right progression of the affinities of the *Ungulata* was broken by the interposition of the Horse and other Perissodactyles between the non-ruminant or omnivorous and ruminant Artiodactyles; and that too high a value had been assigned to the Ruminantia by making them equivalent to all the other Ungulates collectively.‡

The third division of the *Gyrencephala* enjoy a higher degree of the sense of touch through the greater number and mobility of the digits, and the smaller extent to which they are covered

* In a new-born Dromedary (*Camelus Dromedarius*, L.), which perished in the birth at the London Zoological Gardens, the following was the state of the dentition. In the upper jaw there were six deciduous incisors (3—3), which were calcified, and presented a larger proportional size than any rudiments of those teeth that have been noticed in ordinary Ruminants, and they leave conspicuous alveoli in the premaxillaries: the deciduous canine and first functional milk-molar (*d.* 2) were small, the latter with a simple crown; the second (*d.* 3) and third (*d.* 4) molars were large, bilobed, and each lobe was bicrescentic. In the lower jaw the six incisors and two canines form a semicircular series of nearly equal teeth, with overlapping leaf-shaped crowns, the deciduous canines more resembling the incisors than the permanent ones do: the functional molars are but two in number, on each side; the first is small, simple, conical, compressed, notched behind; the second is very large and three-lobed, each lobe being bicrescentic, and the last the largest. Only the summits of the crescents of the molar teeth had pierced the gum (Catal. of Osteology, Mus. Roy. Coll. of Surgeons, vol. ii, p. 577, 4to, 1853).

† Quarterly Journal of the Geological Society, December, 1847.

‡ Since the communication of my paper on the classification and affinities of the hoofed animals to the Geological Society, Nov. 3, 1847, in which the grounds for the division of the *Ungulata* into two orders, according to the parity or imparity of the digits, as proposed in my 'Odontography,' are given in detail, the idea has been ventilated and more or less adopted by M. Pomel (Comptes Rendus de l'Acad. des Sciences, June 19, 1848), and by M. Gervais (Zoologie et Paléontologie Française, p. 42). The latter experienced palæontologist, extending the term 'Pachydermes' to include all the Ungulates, divides them into 'Pachydermes herbivores' and 'Pachydermes omnivores,' respectively equivalent to my *Perissodactyla* and *Artiodactyla*, which latter terms M. Pomel adopts. M. Gervais writes: "Les pachydermes omnivores se lient d'une manière si intime aux Ruminants par les Chevrotains et les Chameaux, qu'il est devenu impossible de séparer, comme ordre différent de celui des Ruminants l'ensemble de ces Pachydermes, autrefois confondus avec les Pachydermes herbivores."—*Op. cit.*, Expl. de Planche, xxxvi, p. 6, 4to, 1854.

rny matter. This substance forms a single plate, in the of a claw or nail, which is applied to only one of the surof the extremity of the digit, leaving the other, usually wer, surface possessed of its tactile faculty; whence the *Unguiculata*, applied to this group, which, however, is restricted and natural than the group to which Linnæus led the term. All the species are 'diphyodont,' and the have a simple investment of enamel.

first order, CARNIVORA, includes the beasts of prey, propo called. With the exception of a few Seals, the incisors $\frac{-3}{-3}$ in number; the canines $\frac{1-1}{1-1}$, always longer than the teeth, and usually exhibiting a full and perfect developas lethal weapons; the molars graduate from a trenchant ;uberculate form, in proportion as the diet deviates from rictly of flesh to one of a more miscellaneous kind. The le is rudimental or absent; the innermost digit is often rutal or absent; they have no vesiculæ seminales: the teats dominal; the placenta is zonular. The Carnivora are diaccording to modifications of the limbs, into 'Pinnigrades,' tigrades,' and 'Digitigrades.' In the Pinnigrades (Walrus, ribe) both fore and hind feet are short, and expanded into webbed paddles for swimming, the hinder ones being fetby continuation of integument to the tail. In the Planti(Bear-tribe) the whole or nearly the whole of the hind orms a sole, and rests on the ground. In the Digitigrades ribe, Dog-tribe, &c.) only the toes touch the ground, the eing much raised.

as been usual to place the Plantigrades at the head of the vora, apparently because the higher order, Quadrumana, is grade; but the affinities of the Bear, as evidenced by instructure, *e. g.*, the renal and genital organs, are closer to al-tribe;* the broader and flatter pentadactyle foot of the grade is nearer in form to the flipper of the Seal than is ore perfect digitigrade, retractile-clawed, long and narrow oot of the feline quadruped, which is the highest and most l of the Carnivora.

next perfection which is superinduced upon the unguicumb is such a modification in the size, shape, position, and ion of the innermost digit, that it can be opposed, as a , to the other digits, thus constituting what is properly l a 'hand.' Those Unguiculates which have both fore

atalogue of the Physiological Series,' Mus. R. Coll. of Surgeons, 4to, vol. ii, . 127. Mr. Waterhouse, in noticing the projecting process on the under side amus, a little in advance of the angle of the lower jaw in the *Ursidæ*, re—"The same character is also found in many Seals (*Phocidæ*), which in sever respects appear to approach the bears."—Proc. Zool. Soc., Sept. 1839.

and hind limbs so modified, or at least the hind limbs, form the order QUADRUMANA. They have $\frac{2-2}{2-2}$ incisors,* and $\frac{3-3}{3-3}$ broad tuberculate molars;† perfect clavicles, pectoral mammæ, vesicular and prostatic glands, a simple or slightly bifid uterus, and a discoid, sometimes double, placenta.‡ The Quadrumana have a well-marked threefold geographical as well as structural division. The Strepsirhines are those with curved or twisted terminal nostrils, with much modified incisors, commonly $\frac{3-3}{3-3}$; premolars $\frac{3-3}{3-3}$ or $\frac{2-2}{2-2}$ in number, and molars with sharp tubercles; the second digit of the hind limb has a claw. This group includes the Galagos, Pottos, Aye-Ayes, Loris, Indris, and the true Lemurs; the three latter being restricted to Madagascar, whence the group diverges in one direction to the continent of Africa, in the other to the Indian Archipelago. The Platyrhines are those with the nostrils subterminal and wide apart; premolars $\frac{3-3}{3-3}$ in number, the molars with blunt tubercles; the thumbs of the fore-hands not opposable or wanting; the tail in most prehensile; they are peculiar to South America. The Catarhines have the nostrils oblique and approximated below, and opening above and behind the muzzle: the premolars are $\frac{2-2}{2-2}$ in number; the thumb of the fore-hand is opposable. They are restricted to the Old World, and, save a single species on the rock of Gibraltar, to Africa and Asia. The highest organized family of Catarhines is tailless, and offers in the Orang and Chimpanzee the nearest approach to the human type.

The structural modifications in the genus *Homo*,—the sole representative of the *Archencephala*,—more especially of the lower limb, by which the erect stature and bipedal gait are maintained, are such as to claim for MAN ordinal distinction on merely external zoological characters. But as I have already argued, his psychological powers, in association with his extraordinarily developed brain, entitle the group which he represents to equivalent rank with the other primary divisions of the class *Mammalia* founded on cerebral characters. In this primary group Man forms but one genus, *Homo*, and that genus but one order, called BIMANA, on account of the opposable thumb being restricted to the upper pair of limbs. The testes are scrotal; their serous sac does not communicate with the abdomen; they are associated with vesicular and prostatic glands. The penis is pendulous,

* With few exceptions in the anomalous *Lemuridæ*.

† Reduced to $\frac{2-2}{2-2}$ in the Marmosets (*Hapale*, *Mydas*).

‡ Among the Platyrhines, the placenta is single in *Mycetes*, double in *Callithrix*: among the Catarhines, the placenta is double in *Macacus*, *Cercopithecus*, and *Semnopithecus*, single in *Troglodytes*.

3 prepuce has a frænum. The mammæ are pectoral. ıcenta is a single, subcircular, cellulo-vascular, discoid

has only a partial covering of hair, which is not merely ve of the head, but is ornamental and distinctive of sex. ıtition of the genus *Homo* is reduced to thirty-two teeth suppression of the outer incisor and the first two premo- the typical series on each side of both jaws, the dental , being :—

$$i.\ \frac{2-2}{2-2},\quad c.\ \frac{1-1}{1-1},\quad p.\ \frac{2-2}{2-2},\quad m.\ \frac{3-3}{3-3}=32.$$

teeth are of equal length, and there is no break in the they are subservient in Man not only to alimentation, ɪeauty and to speech.

ıuman foot is broad, plantigrade, with the sole, not in- as in *Quadrumana*, but applied flat to the ground; the 's vertically on the foot; the heel is expanded beneath; ı are short, but with the innermost longer and much han the rest, forming a 'hallux' or great toe, which is ɔn the same line with, and cannot be opposed to, the ɔes; the pelvis is short, broad and wide, keeping well e thighs; and the neck of the femur is long, and forms angle with the shaft, increasing the basis of support for ık. The whole vertebral column, with its slight alter- 'ves, and the well-poised, short, but capacious subglobu- l, are in like harmony with the requirements of the erect . The widely-separated shoulders, with broad scapulæ nplete clavicles, give a favorable position to the upper ow liberated from the service of locomotion, with com- nts for rotary as well as flexile movements, and termin- a hand of matchless perfection of structure, the fit instru- r executing the behests of a rational intelligence and a :. Hereby, though naked, Man can clothe himself, and l native vestments in warmth and beauty; though de- 3, Man can arm himself with every variety of weapon, ɔme the most terribly destructive of animals. Thus he ɔis destiny as the supreme master of this earth, and of ɛr Creation.

ɛse endeavors to comprehend how Nature has associated ' her mammalian forms, the weary student quits his task onviction that, after all, he has been rewarded with but rfect view of such natural association. The mammalian 3 existed, probably from the triassic, certainly from the olitic period; and has changed its generic and specific ıore than once in the long lapse of ages, during which x has been transacted on this planet by animals of that

high grade of organization. Not any of the mammalian genera of the secondary periods occur in the tertiary ones. No genus found in the older eocenes (plastic and septarial clays, &c.) has been discovered in the newer eocenes. Extremely few eocene genera occur in miocene strata, and none in the pliocene. Many miocene genera of Mammalia are peculiar to that division of the tertiary series. Species indistinguishable from existing ones begin to appear only in the newer pliocene beds. Whilst some groups, as, *e. g.*, the Perissodactyles and omnivorous Artiodactyles, have been gradually dying out, other groups, as, *e. g.*, the true Ruminants, have been augmenting in genera and species.

In many existing genera of different orders there is a more specialized structure, a greater deviation from the general type, than in the answering genera of the miocene and eocene periods; such later and less typical Mammalia do more effective work by their more adaptively modified structures. The Ruminants, *e. g.*, more effectually digest and assimilate grass, and form out of it a more nutritive and sapid kind of meat, than did the antecedent more typical or less specialized non-ruminant Herbivora.

The monodactyle Horse is a better and swifter beast of draught and burthen than its tridactyle predecessor the miocene *Hipparion* could have been. The nearer to a Tapir or a Rhinoceros in structure, the further will an equine animal be left from the goal in contending with a modern Racer. The genera *Felis* and *Machærodus*, with their curtailed and otherwise modified dentition and short strong jaws, become, thereby, more powerfully and effectively destructive than the eocene *Hyænodon* with its typical dentition and three carnassial teeth on each side of its concomitantly prolonged jaws could have been.

Much additional and much truer insight has, doubtless, been gained into the natural grouping of the Mammalia since palæontology has expanded our survey of the class; but our best characterized groups do but reflect certain mental conceptions, which must necessarily relate to incomplete knowledge, and that as acquired at a given period of time. Thus the order which Cuvier deemed the most natural one in the class *Mammalia* becomes the debris of a group, known at a subsequent period to be a more natural order.

We cannot avoid recognizing, in the scheme which I now submit, the inequality which reigns amongst the groups, which our present anatomical knowledge leads us to place in one line or parallel series as orders. I do not mean mere inequality as respects the number and variety of the families, genera, and species of such orders, because the paucity or multitude of instances manifesting a given modification or grade of structure in no essential degree affects the value of such grade or modification.

ıe order *Monotremata* is not the less ordinarily distinct from *Iarsupialia*, because it consists of but two genera, than is ırder *Bimana* from that of *Quadrumana*, because it includes a single genus. So likewise the anatomical peculiarities of *Proboscidia*, *Sirenia*, and *Toxodontia* call, at least, for those ral terms, to admit of the convenient expression of general ɔsitions respecting them; and some of these general propo- ıs are of a value as great as the organic characters of more nded orders.

ıere are residuary or aberrant forms in some of the orders, h, to the systematist disagreeably, compel modifications of haracters that would apply to the majority of such orders. flying Lemurs (*Galeopitheci*), the rodent Lemurs (*Cheiromys*), ılow Lemurs (*Loris*, *Otolicnus*), forbid any generalization as ɜth or nails in the *Quadrumana*, whilst they continue asso- l with that order by the character of the hinder thumb; h, by the way, they possess in common with the pedimanous upials. The large, volant, frugivorous Bats (*Pteropus*) are lly opposed to the application of a common dental character ɜ *Cheiroptera*. They are associated with the insectivorous on account of the common external form arising out of the fication of their locomotive organs for flight, just as the ›ngs and Manatees are associated with the *Cetacea* on account eir resemblance to Fishes arising out of the same modifica- of the locomotive system for an aquatic existence. The .vorous *Cetacea* are now separated from the piscivorous *Ce-* as a distinct order; and with almost as good reason we t separate the frugivorous from the insectivorous *Cheiropte-* .he cases are very nearly parallel.

ıture, in short, is not so rigid a systematist as Man. There eculiar conditions of existence which she is pleased shall ıjoyed by peculiarly modified mammals; these peculiarities : through the rules of structure which govern the majority ecies existing and subsisting under the more general condi- of existence, to which the larger groups of Mammalia are ctively adjusted.

.e class of organs seems to govern one order, another class ıer order; the dental system, which is so diversified in the *upialia* and *Bruta*, is as remarkable for its degree of con- y in the *Rodentia* and *Insectivora*. But, as a general rule, haracters from the dental, locomotive and placental systems ıore closely correlated in the Gyrencephalous orders than in in the inferior subclasses of the Mammalia.

the subjoined tabular view of the classification of the Mam- ı, the groups below the ranks of orders are inserted merely ustrations of those orders, not as equivalent subdivisions, the most natural subdivisions of those orders, into which ; not been the aim of the present paper to enter.

Table of the Subclasses and Orders of the Mammalia.

CLASS.	SUBCLASS.		ORDER.	
MAMMALIA	**Archencephala** *		BIMANA	*Homo.*
	Gyrencephala †	Unguiculata	QUADRUMANA	*Catarrhina. Platyrrhina. Strepsirhina.*
			CARNIVORA	*Digitigrada. Plantigrada. Pinnigrada.*
		Ungulata	ARTIODACTYLA	*Omnivora. Ruminantia.*
			PERISSODACTYLA	*Solidungula. Multungula.*
			PROBOSCIDIA	*Elephas. Dinotherium.*
			TOXODONTIA	*Toxodon. Nesodon.*
		Mutilata	SIRENIA	*Manatus. Halicore.*
			CETACEA	*Delphinidæ. Balænidæ.*
	Lissencephala ‡		BRUTA	*Bradypodidæ. Dasypodidæ. Edentula.*
			CHEIROPTERA	*Frugivora. Insectivora.*
			INSECTIVORA	*Talpidæ. Erinaceidæ. Soricidæ.*
			RODENTIA	*Non-claviculata. Claviculata.*
	Lyencephala §		MARSUPIALIA	*Rhizophaga. Poëphaga. Carpophaga. Entomophaga.*
			MONOTREMATA	*Echidna. Ornithorhynchus.*

ART. XVIII.—*On Chalcodite;* by GEORGE J. BRUSH.

THE name Chalcodite was proposed‖ in 1851 by Prof. C. U. Shepard, for a mineral which occurs at Sterling, N. Y., which had previously been referred to Cacoxene by Beck.¶ Prof. Shepard's analysis showed the mineral to be a hydrous silicate of iron and magnesia. More recently, Prof. Shepard has published** an analysis made by Dr. Mallet which gave the composition:

$\ddot{\mathrm{S}}\mathrm{i}$ 39·77, $\dot{\mathrm{F}}\mathrm{e}$ 40·84, $\dot{\mathrm{M}}\mathrm{n}$ *tr.*, $\bar{\mathrm{A}}\mathrm{l}$ 8·52, $\dot{\mathrm{C}}\mathrm{a}$ 5·98, $\dot{\mathrm{M}}\mathrm{g}$ 1·97, $\dot{\mathrm{H}}$ 5·51 = 102·59,

part of the lime was supposed to be as carbonate and probably

* ἄρχω, to over-rule, ἐγκέφαλος, the brain.
† γυρόω, to wind about, ἐγκέφαλος.
‡ λισσὸς, smooth, ἐγκέφαλος.
§ λύω, to loose, ἐγκέφαλος.
‖ Report Proc. 6th meeting Am. Assoc. Ad. Sci., p. 232.
¶ Beck's Mineralogy of New York, p. 402.
** Shepard's Min., 3d edition, p. iii.

[redacted]

a small portion of the iron existed as sesquioxyd. Dr. Mallet also communicated his results to Prof. Dana* with the remark that he had too little of the mineral for a satisfactory examination, and that the results of his analysis could hardly be depended upon for even a probable formula.

During the past summer I have had an opportunity of examining this mineral at its locality in Sterling, and from the specimens there collected I have obtained the following physical and chemical characters:—

The mineral generally occurs as a thin velvety coating on specular iron; occasionally it is disseminated through calcite, and not unfrequently it is implanted on quartz in small radiated hemispherical masses. Its structure is sometimes radiated but usually the coatings are made up of an aggregate of minute scales; the surface of the coatings often presents crystalline plates, not however, sufficiently well marked to determine the crystalline form. The scales are translucent. Cleavage very distinct in one direction, eminently micaceous.

There are two varieties of the mineral, one has a green color inclining to bronze, while the other has more of a yellow color, and strongly resembles *aurum musivum*. Streak olive-green to yellow. The lustre of both varieties is submetallic. Hardness =1. Sp. gr. =2·76 (at 16° C.).

Before the blowpipe in the closed tube, gives off water; the green variety is changed to a brown or yellow color; the color of the yellow variety darkens on heating and yields the same product as the green. In the forceps it fuses readily in both the oxydizing and reducing flames to a black glass; on charcoal fuses to a magnetic bead; dissolves in borax giving an iron reaction; with soda and nitre shows a trace of manganese; with salt of phosphorus gives reactions for both iron and silica.

I was unable to get enough of the lighter colored variety for an analysis in the wet way, but of the green variety I was fortunate in obtaining through the kindness of Dr. George N. Hubbard of Natural Bridge, N. Y., a specimen in which the Chalcodite formed rectangular crystals of more than half an inch in length, by a quarter of an inch in breadth, and about half a line in thickness. These crystals are evidently pseudomorphs, but the angles are so rounded that it is hardly possible to determine to what species they belong. The mineral forming these crystals is perfectly fresh and unaltered, the exterior of the crystals appears drusy, while interiorly they seem to be made up of minute and irregularly disposed scales. The pulverized mineral is decomposed by hydrochloric acid without gelatinizing; a qualitative analysis showed the presence of silica, alumina, protoxyd

* This Journal, vol. xxiv, p. 113

and sesquioxyd of iron and magnesia, with traces of manganese and lime.

In the quantitative examination in No. 1, the mineral was decomposed by hydrochloric acid, the iron and alumina weighed together and subsequently separated by potash. In No. 2 the water was determined directly by ignition in a stream of dry air and collecting the vapor in a chlorid of calcium tube. The ignited mass was found to be no longer decomposable by hydrochloric acid, and was accordingly fused with carbonate of soda. The iron and alumina were weighed together and the iron afterwards determined volumetrically, by means of permanganate of potash. For the determination of the protoxyd and sesquioxyd of iron as given in Nos. 3 and 4, portions of the mineral were dissolved in pure hydrochloric acid in a stream of carbonic acid gas, and the amount of protoxyd determined volumetrically as in No. 2. The whole of the iron was then reduced to the state of protoxyd by sulphuretted hydrogen gas, the solution boiled to expel the sulphuretted hydrogen, allowed to cool free from access of air and the whole amount of iron determined, the difference between which and the amount of protoxyd first obtained gives the amount existing as sesquioxyd.

The results of the analyses are as follows:—

	1.	2.	3.	4.
Quantity taken in milligr'ms,	435	591	338	217
Silica,	45·06	45·51	....	....
Alumina,	3·56	3·68	....	....
Sesquioxyd of iron,	38·85	38·61	20·92	20·02
Protoxyd of iron,	....	....	16·04	16·91
" of manganese,	*trace.*	*trace.*	....	....
Lime,	*trace.*	0·28	....	....
Magnesia,	4·55	4·57	....	....
Potash and Soda,	*trace.*	....	....	....
Water,	....	9·22	....	....

The mean of these analyses gives:—

		Oxygen.		Ratio.
$\dddot{\mathrm{Si}}$	45·29	23·53	23·53	3
$\dddot{\bar{\mathrm{Al}}}$	3·62	1·69	7·83	1
$\dddot{\bar{\mathrm{Fe}}}$	20·47	6·14		
$\dot{\mathrm{Fe}}$	16·47	3·66	5·56	⅔
$\dot{\mathrm{Mn}}$	*trace.*	....		
$\dot{\mathrm{Ca}}$	0·28	·08		
$\dot{\mathrm{Mg}}$	4·56	1·82		
$\dot{\mathrm{Na}}, \dot{\mathrm{K}}$	*trace.*	....	....	
$\dot{\bar{\mathrm{H}}}$	9·22	8·18	8·18	1
	99·91			

This ratio gives a formula which may be expressed by

$$2\dot{R}\,\dddot{\mathrm{Si}}+\dddot{\bar{R}}\,\dddot{\mathrm{Si}}+3\dot{\bar{\mathrm{H}}}$$

This composition approaches that given by Rammelsberg,* (analyses 1, 2, 3, and 4,) and Siegert,† (analysis 5,) for Stilpnomelane:

	$\dddot{Si}$	$\bar{\ddot{Al}}$	$\bar{\ddot{Fe}}$	$\dot{Fe}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{K}, \dot{Na}$	$\dot{H}$	
1.	43·19	8·16	....	37·05	3·34	1·19	....	5·95	From Obergrund, near Zuckmantel in Austrian Silesia.
2.	46·50	7·19	....	33·39	1·89	0·20	....	7·90	
3.	45·43	5·88	....	35·38	1·68	0·18	....	9·28	
4.	46·17	5·88	....	35·82	2·67	....	0·75	8·72	
5.	42·07	4·92	41·98	....	0·94	1·67	....	8·47	From Weilburg in Nassau.

Siegert assumes the iron to exist as sesquioxyd while Rammelsberg gives it as protoxyd, with the remark that if it be calculated as $\dot{Fe}\bar{\ddot{Fe}}$, the analyses will give an excess, and therefore *perhaps* it only exists as protoxyd in the mineral.

It is evident from the results of analyses 1 to 4 that the stilpnomelane analyzed was not entirely free from foreign substances, and Rammelsberg mentions that it may possibly have been mixed with some chlorite, and that this is the reason for the difference in the results.

Analyses 3 and 4 correspond very closely with the analysis of chalcodite, and it is possible that if a special examination were made to determine the proportionate amounts of protoxyd and sesquioxyd of iron in stilpnomelane, the two minerals might be found even more nearly related.

The fact that stilpnomelane is but imperfectly decomposed by acids, while chalcodite is entirely decomposed, may be due to the extreme delicacy of the scales in the latter; the same cause will account for the difference in hardness. The specific gravity is 3·0—3·4 Glocker, or according to a more recent determination by Breithaupt, 2·769. Chalcodite has a density of 2·76. Stilpnomelane occurs both foliated and compact; its color is blackish-green, streak olive-green to greenish-gray; it has a pearly lustre and a perfect cleavage in one direction. A specimen from the Weilburg locality which I have in my cabinet bears a very strong resemblance to the green variety of chalcodite in its external appearance.

The marked similarity in chemical, as well as in many of the physical characters of these two minerals renders it not improbable that a reëxamination of pure stilpnomelane would remove those discrepancies which at present prevent their being united under one species.

Yale Analytical Laboratory, Dec. 15, 1857.

* Poggend. Ann., xliii, 127.
† Rammelsberg, Mineralogie, Fifth Suppl., 203.

ART. XIX.—*Agassiz's Contributions to the Natural History of the United States.*

THE publication of the first two volumes of the "Contributions to the Natural History of the United States" by Professor Agassiz was announced in our last number, and a statement, in brief, made of their contents. The philosophical merits of the work, as well as its national character, entitle it to a more detailed notice.

While the special subject in American zoology selected for the volumes is the Embryology of Turtles, the first of the two is mainly occupied with general considerations on the system in the kingdoms of life—a topic, of wide import to science, making an appropriate introduction to the great work.

These opening chapters have also a peculiar interest for the sketch they indirectly give of the author. Deep topics in science occupy his thoughts. But through all, appears that love of truth, which is the living force of a philosopher; that faith in nature as God's work, which gives to science its highest dignity; that desire to read the minutest tracings in the great volume, which the knowledge that all the grandeur of creation is brought out through infinitesimals, naturally inspires; that sensitiveness of mental organization which perceives the faintest voices of nature, and thrills to the profound harmonies in which those voices combine to utter the deep thoughts of creation. These qualities all shine forth from the pages as they could not from any portrait or biography.

A successful searching out of nature's laws requires faith in the fullness of the revelation, and in finite mind as the interpreter. This faith, moreover, should be coupled with a profound sense of nature's oneness in law, purpose and Author. The mind should also be open to the slightest breath of truth from whatever source, quick in its perceptions of parallelisms and analogies, and just in balancing fact against fact, relation against relation, so that all shall take their true position, and evolve, from their mutual action, the thought of which nature, not the mind, is the author. It is true that complete perfection of action is not human: for minds almost necessarily run in channels that limit their thoughts and vision; they are apt to be drawn aside by the delight of special views, and too often seek novelty and self-exaltation in place of truth: and all systems of philosophy suffer more or less from these sources of evil. He is the true student of nature, although thus imperfect, who seeks that nature should speak through him, and strives to express the sentiments that come forth at her dictation. And far profounder is his apprehension of truth when he realizes, in all its significance, that an

Infinite Spirit—infinitely good, just and wise—speaks through nature to man's heart as well as mind. Only a short-sighted naturalist fails to perceive that the affections and moral sentiments, in their perfection, are among the creations, and that pre-eminently they manifest the character of the Creator.

In striking contrast with the searching philosopher is the one who stands aside and doubts research, while he dictates self-wrought thoughts. Professor Agassiz, in several of his chapters, points his forcible argument against such a one—a distinguished physicist of Oxford, England. Neither geology nor zoology has discovered a foundation for the principle that species pass into other species by gradual change: but *he* says *perhaps* they do in the course of a great length of time. Geology has not detected the smallest fact to sustain the so-called development theory: but he says, perhaps it is still true. And then he goes on to propound his views, building up his theories on the basis of a *perhaps*, itself baseless, in direct opposition to the inductive system of philosophy which he would sustain.* So we find others, instead of taking the facts as they are known, and deriving from them the impression they are calculated to make and the laws they dictate, saying, *perhaps* geology in the end will find the past very much like the present, with no system of progress in the life of the globe;—while they cannot go from case to case in a cabinet illustrating this life according to the ages, without seeing the progression at every step. The mind becomes smothered under a *perhaps*, and rests in darkness and doubt, instead of coming out to the light and using it. Such men have their place, for they are checks on hasty theorizing; while the mere theorist that defies or disregards nature, is only following his own torch-light to error. As all our knowledge of nature's laws rests upon inductive reasoning, a mind that will doubt the

* There was doubt in many minds when the "Vestiges of Creation" was first published, whether such a development theory might not be true. But the facts exactly interpreted were soon found to be against it, and every year has added to the force of the demonstration. The sweeping destructions of species in geology have shown that there was a Creative Power that could reinstate the life of a continent without going back to the Monad. The N. American continent gives a striking example of such a destruction in the catastrophe which swept off Palæozoic life, and was followed here by not a single old species or peculiarly Palæozoic genus, but by the reptiles and birds of the Triassic or Jurassic. These facts and the actual independence of species, according to both geology and zoology, so stand before the scientific world at the present time, that the inductive philosopher must wait for new revelations from science, before he can, in the spirit of his philosophy, propound any such development theory. Let him study out facts respecting variations of species and find a basis to stand upon, and then he may march safely to his conclusions; and this is a great subject for study. But to push forward the view in advance of the facts, and *against* the present array of facts, is indulging in deluding speculation. Let him bring out his law, as a result of study, and tell us, what species of ox or other Ungulate was developed into a mastodon, or how the mastodon was developed into an elephant, and his theory then will merit a hearing. We cite beyond other views from Professor Agassiz which bear upon this subject.

firmest conclusions on the ground that the contrary *may* still be right, is hopelessly impregnable to truth. The two modifications of skepticism above alluded to, the speculative and the matter-of-fact, have each their remedy, in a principle which will prove effectual if received and appreciated: the *first*, in the truth that nature is the only source of knowledge about nature,—whence to attempt to lead off, instead of follow, is presumptuous:—the *second*, that the universe, however complex to common view, is, as above observed, an expression of unity of law, both in plan and history, and that a grand purpose of facts is to illustrate this unity. These two principles are united in Prof. Agassiz, and in connection with his habit of exact and untiring research, make him what he is in science.

The first volume of the Natural History of the United States is devoted mainly to *classification* taken in its most comprehensive sense, including whatever illustrates those relations of species upon which classification depends, as well as the nature of classification itself.

The author declares, in the outset, his views of the world of existences, which science aims to comprehend. With much earnestness, he discourses upon nature as a divine system; on thought as no property of matter, and God as not nature. He pronounces the study of natural science the study of the thoughts or ideas which the Creator has embodied in his works, and a true classification of objects in nature as an exhibition of the plan ordained by Him in his omniscience and wisdom. On page 10 we read:—

"I disclaim every intention of introducing in this work any evidence irrelevant to my subject, or of supporting any conclusions not immediately flowing from it; but I cannot overlook nor disregard here the close connection there is between the facts ascertained by scientific investigations, and the discussions now carried on respecting the origin of organized beings. And though I know those, who hold it to be very unscientific to believe that thinking is not something inherent in matter, and that there is an essential difference between inorganic and living and thinking beings, I shall not be prevented by any such pretensions of a false philosophy from expressing my conviction, that, as long as it cannot be shown that matter or physical forces do actually reason, the manifestation of thought is evidence of the existence of a thinking being as the author of such thought, and I shall look upon an intelligent and intelligible connection between the facts of nature as direct proof of the existence of a thinking God, as certainly as man exhibits the power of thinking when he recognizes their natural relations."

Through the discussions which follow, the question of creation by means of physical forces or agencies is considered. On page 13 he says:—

"It is the object of the following paragraphs to show that there are neither agents nor laws in nature known to physicists under the influence, and by the action, of which, these beings could have originated; that, on the contrary, the very nature of these beings and their relations to one another and to the world in which they live, exhibit thought, and can therefore be referred only to the immediate action of a thinking being, even though the manner in which they were called into existence remains for the present a mystery."

The arguments bearing on this topic, which are numerous and variously illustrated, are recapitulated in brief on pages 132 to 135.

"In recapitulating the preceding statements, we may present the following conclusions:—

"1. The connection of all these known features of nature into one system exhibits thought, the most comprehensive thought, in limits transcending the highest wonted powers of man.

"2. The simultaneous existence of the most diversified types under identical circumstances exhibits thought, the ability to adapt a great variety of structures to the most uniform conditions.

"3. The repetition of similar types, under the most diversified circumstances, shows an immaterial connection between them; it exhibits thought, proving directly how completely the Creative Mind is independent of the influence of a material world.

"4. The unity of plan in otherwise highly diversified types of animals, exhibits thought; it exhibits more immediately premeditation, for no plan could embrace such a diversity of beings, called into existence at such long intervals of time, unless it had been framed in the beginning with immediate reference to the end.

"5. The correspondence, now generally known as special homologies, in the details of structure in animals otherwise entirely disconnected, down to the most minute peculiarities, exhibits thought, and more immediately the power of expressing a general proposition in an indefinite number of ways, equally complete in themselves, though differing in all their details.

"6. The various degrees and different kinds of relationship among animals which can have no genealogical connection, exhibit thought, the power of combining different categories into a permanent, harmonious whole, even though the material basis of this harmony be ever changing.

"7. The simultaneous existence, in the earliest geological periods in which animals existed at all, of representatives of all the great types of the animal kingdom, exhibits most especially thought, considerate thought, combining power, premeditation, prescience, omniscience.

"8. The gradation based upon complications of structure which may be traced among animals built upon the same plan, exhibits thought, and especially the power of distributing harmoniously unequal gifts.

"9. The distribution of some types over the most extensive range of the surface of the globe, while others are limited to particular geographical areas, and the various combinations of these types into zoölogical provinces of unequal extent, exhibit thought, a close control in the distribution of the earth's surface among its inhabitants.

"10. The identity of structure of these types, notwithstanding their wide geographical distribution, exhibits thought, that deep thought which, the more it is scrutinized, seems the less capable of being exhausted, though its meaning at the surface appears at once plain and intelligible to every one.

"11. The community of structure in certain respects of animals otherwise entirely different, but living within the same geographical area, exhibits thought, and more particularly the power of adapting most diversified types with peculiar structures to either identical or to different conditions of existence.

"12. The connection, by series, of special structures observed in animals widely scattered over the surface of the globe, exhibits thought, unlimited comprehension, and more directly omnipresence of mind, and also prescience, as far as such series extend through a succession of geological ages.

"13. The relation there is between the size of animals and their structure and form, exhibits thought: it shows that in nature the quantitative differences are as fixedly determined as the qualitative ones.

"14. The independence in the size of animals of the mediums in which they live, exhibits thought, in establishing such close connection between elements so influential in themselves and organized beings so little affected by the nature of these elements.

"15. The permanence of specific peculiarities under every variety of external influences, during each geological period, and under the present state of things upon earth, exhibits thought: it shows, also, that limitation in time is an essential element of all finite beings, while eternity is an attribute of the Deity only.

"16. The definite relations in which animals stand to the surrounding world, exhibit thought; for all animals living together stand respectively, on account of their very differences, in different relations to identical conditions of existence, in a manner which implies a considerate adaptation of their varied organization to these uniform conditions.

"17. The relations in which individuals of the same species stand to one another, exhibit thought, and go far to prove the existence in all living beings of an immaterial, imperishable principle, similar to that which is generally conceded to man only.

"18. The limitation of the range of changes which animals undergo during their growth, exhibits thought; it shows most strikingly the independence of these changes of external influences, and the necessity that they should be determined by a power superior to those influences.

"19. The unequal limitation in the average duration of the life of individuals in different species of animals, exhibits thought; for, however uniform or however diversified the conditions of existence may be under which animals live together, the average duration of life, in different species, is unequally limited. It points, therefore, at a knowledge of time and space, and of the value of time, since the phases of life of different animals are apportioned according to the part they have to perform upon the stage of the world.

"20. The return to a definite norm of animals which multiply in various ways, exhibits thought. It shows how wide a cycle of modulations

may be included in the same conception, without yet departing from a norm expressed more directly in other combinations.

"21. The order of succession of the different types of animals and plants characteristic of the different geological epochs, exhibits thought. It shows, that while the material world is identical in itself in all ages, ever different types of organized beings are called into existence in successive periods.

"22. The localization of some types of animals upon the same points of the surface of the globe, during several successive geological periods, exhibits thought, consecutive thought: the operations of a mind acting in conformity with a plan laid out beforehand and sustained for a long period.

"23. The limitation of closely allied species to different geological periods, exhibits thought; it exhibits the power of sustaining nice distinctions, notwithstanding the interposition of great disturbances by physical revolutions.

"24. The parallelism between the order of succession of animals and plants in geological times, and the gradation among their living representatives, exhibit thought; consecutive thought, superintending the whole development of nature from beginning to end, and disclosing throughout a gradual progress, ending with the introduction of man at the head of the animal creation.

"25. The parallelism between the order of succession of animals in geological times and the changes their living representatives undergo during their embryological growth, exhibits thought; the repetition of the same train of thoughts in the phases of growth of living animals and the successive appearance of their representatives in past ages.

"26. The combination, in many extinct types, of characters which, in later ages, appear disconnected in different types, exhibits thought, prophetic thought, foresight; combinations of thought preceding their manifestation in living forms.

"27. The parallelism between the gradation among animals and the changes they undergo during their growth, exhibits thought, as it discloses everywhere the most intimate connection between essential features of animals which have no necessary physical relation, and can, therefore, not be understood otherwise than as established by a thinking being.

"28. The relations existing between these different series and the geographical distribution of animals, exhibit thought; they show the omnipresence of the Creator.

"29. The mutual dependence of the animal and vegetable kingdoms for their maintenance, exhibits thought; it displays the care with which all conditions of existence, necessary to the maintenance of organized beings, have been balanced.

"30. The dependence of some animals upon others or upon plants for their existence, exhibits thought; it shows to what degree the most complicated combinations of structure and adaptation can be rendered independent of the physical conditions which surround them.

"We may sum up the results of this discussion, up to this point, in still fewer words:—

"All organized beings exhibit in themselves all those categories of structure and of existence upon which a natural system may be founded, in such a manner that, in tracing it, the human mind is only translating into human language the Divine thoughts expressed in nature in living realities.

"All these beings do not exist in consequence of the continued agency of physical causes, but have made their successive appearance upon earth by the immediate intervention of the Creator. As proof, I may sum up my argument in the following manner:

"The products of what are commonly called physical agents are everywhere the same, (that is, upon the whole surface of the globe,) and have always been the same (that is, during all geological periods); while organized beings are everywhere different and have differed in all ages. Between two such series of phenomena there can be no causal or genetic connection.

"31. The combination in time and space of all these thoughtful conceptions exhibits not only thought, it shows also premeditation, power, wisdom, greatness, prescience, omniscience, providence. In one word, all these facts in their natural connection proclaim aloud the One God, whom man may know, adore, and love; and Natural History must, in good time, become the analysis of the thoughts of the Creator of the Universe, as manifested in the animal and plant [and crystal] kingdoms."

If after all, we hear it said still,—that *perhaps* creations may have been due to physical forces—we would repeat, that the notion comes not through science or true inductive philosophy; in all the search thus far, no authority for such an inference has been found. Electricity and its associates we know, but nothing about life-creating force; the daily progress of science is defining, with increasing clearness, the physical agencies of nature, and at the same time stripping them of their old fabulous virtues. The method of creation of a living species appears now, more than ever before, to be a subject beyond the pale of human research—the limit in which man seemingly comes to the precincts of the Infinite. We may look for knowledge; but until nature opens to us a new avenue, this *perhaps* should be set down among man's presumptuous dreamings.

Another topic introduced in connection with the discussions on classification, is that of the relations of the grand system of life and also individual history in species to geological progress. Although the subject is but briefly and collaterally brought in, it is of too much general interest to be passed by without a mention of the views sustained by the author. We arrange the points with reference to their geological bearing.

Professor Agassiz argues with truth that the oldest fossils represent the beginning of animal life on the globe, so far at least as to give a correct exhibition of the earliest types. For the series has its initial point in the same kinds of species on all the continents, reaching down, on each, to salt-water Articulates,

Molluscs and Radiates, if not also to salt-water Vertebrates (Fishes). The great Branches of the animal kingdom thus begin in the inferior or salt-water species; and any obliterated records below, if such there be, could only extend onward this idea, or modify it by limiting somewhat more the range of types.

The author also observes, that the series, thus begun, reached its end in man, and that it admits of proof on anatomical evidence that man is the last term in the series; that upon the earth, no material progress beyond is possible in the plan upon which the animal kingdom is constructed, except in man's own intellectual and moral development. This conclusion follows in fact from the simple progression of form among Vertebrates from the fish onward;—for there is first the horizontal or prone position of the nervous cord with which the series begins,—then the gradual elevation of the cephalic extremity with the new types introduced, and at last the vertical position in man—a *necessary* limit to the series.

The actuality of the progress of life is touched upon and shown to be illustrated through the whole range of geological history. A descending or ascending series of numbers, part of which series is understood, may be easily followed by the mind towards its limits. Of this nature are the facts in geology. The discovery of a type of form at a lower level in the series of strata than before known occasionally takes place; but in no case has the new fact tended to alter essentially the law of the ascending series.

Seaweeds: Ferns and Coniferæ: Angiosperms and Palms;—such is a brief statement of the series in the plant kingdom.

Entomostraca: Tetradecapoda, Anomoura, Macroura: Lower Brachyura: Higher Brachyura;—is the series in Crustacea.

Fishes: Reptiles: Quadrupeds: Man;—is the series among Vertebrates.

The same general idea is illustrated among all the great groups.

Now and then a fact appears that startles the timid, as if nature were not going to prove true to herself. There has been recently discovered a number of new mammalian fossils in the Oolite of Stonesfield, England. But though of great interest, they were but the following out of a discovery made in the same beds thirty-five years ago; and during the interval, mammalian remains have been traced only into the Trias, the beds of the next earlier period. In all, fourteen species have been found in a layer—once evidently a dirt-bed—which is *only five inches thick, and from an area only* 500 *square yards in extent.* The facts, instead of favoring the idea of discovering related fossils in the Carboniferous, renders its probability almost infinitely small. For if such a bed, five inches thick, affords so large a number, then strata like the Coal Measures, abounding

in dirt-beds, thick and thin, and with numerous great beds of land vegetation also, through a series of strata five to fifteen thousand feet thick, a large part of which strata are not marine, ought to afford fossil mammals without limit. It is easy to work out the proportion; and in doing so, it should be remembered that no beds of rock have been more explored, man's cupidity giving great activity and thoroughness to the investigation. The answer to the simple problem would be, some hundreds if not thousands; and yet, notwithstanding all the chances, and all the labor thus far bestowed, not a specimen has been found.

There being some system of progress, the great question is, What is that system?

Is it a law of uniform progress for the Animal Kingdom as a whole? No:—for each of the four Branches, as Professor Agassiz observes, are wholly independent of each other in their whole system of structure and progress.

Is it a law of uniform progress for each of these Branches? or for each of the Classes they contain, as for the class of fishes, or of birds, or of mammals, etc.? The same argument which is used above for the Branches, holds in fact against any such kind of progress for the Classes, Orders, Families and Genera of the Animal Kingdom. For the groups, of either grade, have usually a degree of independence similar to the Branches—a principle which Agassiz insists upon as *universal* for all natural groups, and which certainly holds as a *general* truth. We should therefore no more look for lineal progression between different Orders in a Class, or different Classes in a Branch, than between different systems in the heavens.

In addition to this, a class has not generally been first introduced through the creation of its very simplest species.

On this point, Professor Agassiz says: "The earliest representatives of these classes do not always seem to be the lowest. Yet through all the intricate relations, there runs an evident tendency towards the production of higher and higher types, until, at last, man crowns the series." And he closes this paragraph with the sentiment which seems to be ever dwelling in his mind: "Who can look upon such series, and not read in them the successive manifestations of a thought expressed at different times, in ever new forms, and yet tending to the same end, onwards to the coming of man, whose advent is already prophesied in the first appearance of the earliest fishes?"

This general truth, that the progress is not always, we should say, not commonly, even for small groups, a lineal one, is often misunderstood, and made the basis for reproaches against any idea of progress. Every growing embryo has its superior and also inferior developments; and something analogous is obviously true in zoological history. Each type has usually been

introduced by creations of species that belong to one of its inferior groups, but yet, when so, these earliest forms were not generally the very lowest; and as the expansion of the type afterward took place through new creations, there were downward steps as well as upward, though the upward were eminently the most marked.

Prof. Agassiz appears at times to insist upon an invariably upward progress; but in the above citation, he recognizes the want of generality in the law. If our announcement of the principle is a modification of his view, it appears to us to be one involved in his own statements. As examples of it, the Trilobites were not the lowest of Crustaceans; nor the old Ganoids, the lowest of fishes; nor the Acrogens of the Coal Period, the lowest of land Cryptogams, Mosses and perhaps other orders coming in much later; so also snakes were of later creation than saurians. Quadrupeds, according to the fossils thus far discovered, first appeared in the Marsupials (implacentals), the lower order of Mammalia, and perhaps also in Insectivores, one of the inferior types of placental mammals. But Edentates, the lower of the placentals, and but a single grade above Marsupials appear to have been introduced after Carnivores and Ungulates, and had their time of fullest expansion in the Post-tertiary period. Further discoveries may modify our knowledge respecting this particular case. But the principle is too generally brought out to view, to be set aside, that, through the successive creations, the expansion was to lower as well as higher forms, while mainly to the higher; in all cases, it brought out a purer development of the type and a fuller exhibition of its various capacities.

The fact of progress is none the less true under such a system. Its actual law is daily receiving new illustrations from geological discoveries and becoming gradually intelligible to us in its various details. A hope, which some seem to have, that new facts will throw despite on all general views, is of shallow growth. None need fear that nature will ever prove her own lawlessness.

The important principles connected with this system of progress, brought out by Prof. Agassiz, are as follows:—

FIRST, "*A parallelism between the geological succession of animals and the embryonic growth of their living representatives.*" The young *Comatula*, Prof. A. observes, has first the form of a *Cystidean;* next that of the *Platycrinoid* of the Carboniferous; next that of the *Pentacrinus* of the Lias and Oolite with their whorls of cirrhi; and finally, there is the free *Comatula*, the highest of the Crinoids. With regard to Asterioids and Echinoids, he observes, p. 114:—

"The investigations of Müller upon the larvæ of all the families of living Asterioids and Echinoids enable us to extend these comparisons to the higher Echinoderms also. The first point which strikes the observer

in the facts ascertained by Müller, is the extraordinary similarity of so many larvæ, of such different orders and different families as the Ophiuroids and Asterioids, the Echinoids proper and the Spatangoids, and even the Holothurioids, all of which end, of course, in reproducing their typical peculiarities. It is next very remarkable, that the more advanced larval state of Echinoids and Spatangoids should continue to show such great similarity, that a young Amphidetus hardly differs from a young Echinus. Finally, not to extend these remarks too far, I would only add, that these young Echinoids (Spatangus as well as Echinus proper) have rather a general resemblance to Cidaris, on account of their large spines, than to Echinus proper. Now, these facts agree exactly with what is known of the successive appearance of Echinoids in past ages; their earliest representatives belong to the genera Diadema and Cidaris, next come true Echinoids, later only Spatangoids. When the embryology of the Clypeastroids is known, it will, no doubt, afford other links to connect a larger number of the members of the series."

The young Ganoid of our lakes and rivers has the prolonged caudal vertebral column of the ancient Ganoid; and all the ancient fishes have cartilaginous internal skeletons instead of bony, being thus like the young of the later osseous fishes. Again, among Reptiles, the tailed Batrachians appear to have preceded the tail-less, as the tad-pole precedes the frog in development at the present day. The crabs in their growth pass through a macroural and anomoural form, starting often from an Entomostracan; and the same is the order of creations in geological history. The earlier quadrupeds, as well as other species, in many cases present peculiarities of structure which are now known as embryonic or only temporary conditions in the growth of existing species; Professor Owen alludes to facts of this kind on page 192 of this volume.

It is seen from the preceding and following remarks, that this law, while true as a great principle, has its limitations.

SECOND. *A parallelism between the geological succession of animals and relative rank among groups or species.* This law is in fact involved in the preceding, in connection with another principle, first propounded by Prof. Agassiz, that the series of successive forms in embryological development affords a scale for ascertaining the grade of species in any given order. If the progress was on the whole from the lower to the higher, and if the grades are marked off in the stages of embryonic growth, then the geological progress should have a degree of parallelism with the successions in embryo development. Agassiz hence finds criteria for ascertaining the rank of groups or species in classification, both in the stages of embryonic growth, and in the stages or steps in the geological history of life. Relations of form or structure to the earlier steps in the former, or the earlier types in the latter, indicate inferiority of grade, and relations to the later, superi-

ccording to a scale easily apprehended. The worm-like lower stage of an insect, attests that worms and crus- are inferior in grade to insects. And in general, a multi- of segments and laxity of parts are proofs of inferiority: se accordance, the Trilobites, the earliest of Crustaceans excessive multiplication of segments.* But to use the of geological history with success, the principle already hat the order of progress is only *in a general way* from er to the higher, that is, that the earliest are not always lowest, must be borne in mind.

principle or general truth in embryology is based upon another of a po- therefore more fundamental character,—one which the writer has illus- is U. S. Expl. Exp. Report on Crustacea (chapter on Classification, p. 1395, ournal, xxii, 14). It is this, that cephalic elevation as to quality or grade nt with—and we may say, that in individual growth it is potentially con- h—caudal or posterior abbreviation; and attending it, there is, also, a mpacting of the body and often contraction in size. It is concentration lization, and hence progress. All development from the young upward is degree this kind of cephalic progress,—an elevation in the sensorial or- he anterior extremity of the body, as well as a compacting of the struc- s it is in the insect in passing from the larva to the imago; in the frog d fish in passing from the tadpole to the adult; in the crab, in changing acroural larve to the perfect animal, and so, generally, through the Ani- lom. Comparing groups of species together, the principle comes out in a prehensive form. The tape-worm, a worm without a proper head, is in- length; moreover each segment is equal to its neighbor and capable of g by itself the complete animal. But in worms of higher grade, having ere is a limit to the length, and this power of self-reproduction does not the Crustacean there is a still smaller number of segments, and concen- the anterior part into a circumscribed cephalothorax. In the Crab, the ustacean, the effect is carried to its extreme in the Crustacean type, the having become very small and lost its members in the extreme thoracico- ion. In the insect, the body is much shorter and every way far smaller e Crustacean, and besides, there is a concentration of the anterior part in- ct head, separate from the thorax. Again, the lizard has fewer segments nake. The higher quadruped has more vertebræ coalesced in the sacrum re firmly compacted cranium than the inferior quadruped: that is, as in , the cephalothorax, viewing its whole length to the caudal extremity, is pacted and abbreviated as the grade rises.

nciple explained appears to be a general one. But the comparisons be- erent species or groups afford right conclusions only when made among the same typical series; for when a type as a whole is inferior in grade , we cannot of course pass from one to the other in drawing such inferen- eover each type has its degradations (that is, species representing degraded erate forms); and in this depauperation there is an abbreviation analogous ising from the opposite principle, cephalization. While the tape-worm is lowest of species, there are others still inferior which are little better gle segment of the tape-worm. While, again, the Decapod Crustacean as grade, has its abdomen shortened till it becomes memberless in the Crabs, lower end of the scale of Decapods (the Schizopodous group), there are e species which have a memberless abdomen. The principle is then, that type, a rising of grade is shown in concentration anteriorly, and abbre- steriorly; and a degradation in a relaxation or multiplication of parts, longation posteriorly; a still farther enfeebling is manifested in an obco- osteriorly, and sometimes so anteriorly, as well as a general debility of d system. It is hardly necessary to add that no change of species into erior is here implied, but that actual species represent the conditions men- .

THIRD. *The frequent synthetic character of the earlier types.* The Ganoid fishes are a familiar illustration, being often called Sauroid fishes, as they include certain reptilian characteristics in their structure. They are *synthetic* types. To the Ganoids (and in other cases when a future group is foreshadowed), the term *prophetic* type is applied by Agassiz. In after time, fishes come out purely fishes in the Ctenoids and Cycloids, and this is, in part, the kind of expansion or evolution the Fish type underwent. The arborescent Acrogens of the Coal Period appear also to have been synthetic types, combining certain Coniferous characteristics with those of the Fern type. In this case the two component types, the fundamental one and the collateral, were of the same geological age. The Cycadeæ, which prevailed especially in the Middle Reptilian Age, while properly Coniferous, have features of both the Fern type and that of the Palms, the former of these from ancient time, the latter prophetic of the future. The Trilobites constitute, as appears to us, another synthetic type, being Entomostracan, with some peculiarities also of the Isopods (Tetradecapodan). In the Reptilian Age, the Anomoura—a group made up of degraded Brachyura, in which there are many Macroural characteristics—preceded in general the most of the Macroural types as well as the Brachyura. Thus in the early Faunas and Floras the types covered we may say a wider range in their characters; as time moved on, the same space was occupied with analogous types restricted to narrower and deeper channels, that is with stronger, purer, and a more limited range of characteristics; while others, both of superior and inferior grades (and many of them distinctly foreshadowed), were introduced to fill out the scheme.

In the most comprehensive terms, the law is *The general before the special,* the great principle in embryological development, which, as Professor Agassiz observes, von Baer first studied out and thoroughly elucidated.* It is not presented in geology in a manner to favor the notion of the creation of species from species, but rather as an exhibition of unity of idea between growth in the individual, grade of species in the system of nature, and progress in the geological history of life.

A FOURTH law is that of *the culmination and disappearance of types in past time.* The Trilobites, which begun and ended in the Palæozoic ages; the Ammonite group which commenced in the Palæozoic and ended with the Reptilian age; the Brachiopods and Ganoids which first appeared in the Palæozoic and reach on to the present era, though almost wholly extinct—are familiar examples. This is obviously parallel with the fact in embryological development, that parts may fulfil their end and disappear

* This subject is illustrated in its geological bearings at some length in Carpenter's Comparative Physiology, 4th edition.

before the final adult stage is reached. Professor Agassiz, in his remarks on the succession of types, appears to argue that throughout *classes* and *orders* in the Animal Kingdom there was a rising of grade among the species to the last; that is, among the species now existing as representatives of an order, the higher are of superior rank to those representing that order in any earlier time. But perhaps this point requires a farther survey of the facts. It does not seem to be established that the Carnivora of the present age are superior in grade to those of the Post-tertiary, or the Cephalopods of our own seas to those of the Reptilian Age.

After considering many of the laws of relation among animals and between the animal and plant kingdoms, Professor Agassiz introduces an illustration of still wider unity embracing the physical world at large, first suggested by his associate at Cambridge, Professor Peirce. As the facts have not been published in this Journal, we cite a few paragraphs from the chapter. It is well known that the leaves of plants are arranged in spirals, and that the intervals between two successive leaves in the spirals for different plants, varies between $\frac{1}{2}$ and $\frac{1}{3}$d of the circumference; the actually occurring numbers afford the mathematical series $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, $\frac{21}{55}$, etc.; in which the numerator and denominator of each term equals severally the sum of the numerators, and of the denominators, of the two terms next preceding.

"Now, upon comparing this arrangement of the leaves in plants with the revolutions of the members of our solar system, Peirce has discovered the most perfect identity between the fundamental laws which regulate both, as may be at once seen by the following diagram, in which the first column gives the names of the planets, the second column indicates the actual time of revolution of the successive planets, expressed in days, the third column the successive times of revolution of the planets, which are derived from the hypothesis that each time of revolution should have a ratio to those upon each side of it, which shall be one of the ratios of the law of phyllotaxis; and the fourth column, finally, gives the normal series of fractions expressing the law of phyllotaxis.

Neptune,	60,129	62,000		
Uranus,	30,687	31,000		$\frac{1}{2}$
Saturn,	10,759	10,333		$\frac{1}{3}$
Jupiter,	4,333	4,133		$\frac{2}{5}$
Asteroids,	1,200 to 2,000	1,550		$\frac{3}{8}$
Mars,	687	596		$\frac{5}{13}$
Earth,	365	366	$\frac{8}{13}$	$\frac{8}{21}$
Venus,	225	227	$\frac{13}{21}$	
Mercury,	88	87		$\frac{13}{34}$

"In this series the Earth forms a break; but this apparent irregularity admits of an easy explanation. The fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, etc., as expressing the position of successive leaves upon an axis, by the short

way of ascent along the spiral, are identical, as far as their meaning is concerned, with the fractions expressing these same positions, by the long way, namely, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{5}{8}$, $\frac{8}{13}$, $\frac{13}{21}$, $\frac{21}{34}$, etc.

"Let us, therefore, repeat our diagram in another form, the third column giving the theoretical time of revolution.

Neptune,	$\frac{1}{1}$	62,000	60,129
"	$\frac{1}{1}$	62,000	——
Uranus,	$\frac{1}{2}$	31,000	30,687
"	$\frac{1}{2}$	15,500	——
Saturn,	$\frac{2}{3}$	10,333	10,759
"	$\frac{2}{3}$	6,889	——
Jupiter,	$\frac{3}{5}$	4,133	4,333
"	$\frac{3}{5}$	2,480	——
Asteroids,	$\frac{5}{8}$	1,550	1,200
"	$\frac{5}{8}$	968	——
Mars,	$\frac{8}{13}$	596	687
Earth,	$\frac{8}{13}$	366	365
Venus,	$\frac{13}{21}$	227	225
"	$\frac{13}{21}$	140	——
Mercury,	$\frac{21}{34}$	87	88

"It appears from this table, that two intervals usually elapse between two successive planets, so that the normal order of actual fractions is $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, etc., or the fractions by the short way in phyllotaxis, from which, however, the Earth is excluded, while it forms a member of the series by the long way. The explanation of this, suggested by Peirce, is that although the tendency to set off a planet is not sufficient at the end of a single interval, it becomes so strong near the end of the second interval, that the planet is found exterior to the limit of this second interval. Thus, Uranus is rather too far from the Sun relatively to Neptune, Saturn relatively to Uranus, and Jupiter relatively to Saturn, and the planets thus formed engross too large a proportionate share of material, and this is especially the case with Jupiter. Hence, when we come to the Asteroids, the disposition is so strong at the end of a single interval, that the outer Asteroid is but just within this interval, and the whole material of the Asteroids is dispersed in separate masses over a wide space, instead of being concentrated into a single planet. A consequence of this dispersion of the forming agents is, that a small proportionate material is absorbed into the Asteroids. Hence, Mars is ready for formation so far exterior to its true place, that when the next interval elapses the residual force becomes strong enough to form the Earth, after which the normal law is resumed without any further disturbance. Under this law, there can be no planet exterior to Neptune, but there may be one interior to Mercury."—pp. 128, 129.

The subjects to which we have thus far alluded in our notice of Professor Agassiz's work are, as before said, incidental to the author's main purpose, the illustration of the relations of species with reference to principles of classification and the fundamental ideas of system in nature. To this topic we now turn.

(*To be continued.*)

'. XX.—*Contributions to the History of Ophiolites.* Part I; by
Γ. STERRY HUNT, of the Geological Survey of Canada.

ɤ the published reports of the Geological Survey of Canada, W. E. Logan has already shown that the serpentines of Green Mountains occur in the form of beds, and that they ιpy a constant position in the series of altered Lower Silu- strata which make up the principal part of the Green ιntain chain. These metamorphic strata consist of feld- hic, micaceous, epidotic, chloritic, talcose and argillaceous sts, with quartzites, limestones, dolomites and magnesites; des varieties of euphotide and diorite, pyroxenite and dial- rocks, and others consisting essentially of a white lime- ɑina garnet. Intercalated in this series occur the different eties of serpentine rocks about to be described.

'p to the present time, geologists, with few exceptions, have :ed upon serpentine as a rock of igneous origin; but this ɤ is clearly inadmissible for the serpentines of the palæozoic :s of Canada—whose magnesian strata are, as I have endeav- l to show, the result of the alteration of beds of silicious ımite and magnesite, which have been transformed into sili- s under the influence of solutions of alkaline carbonates, a :ess which requires no very elevated temperature, and ena- us to explain the production of those silicates of lime, mag- a and iron which play such an important part in the mineral ɔry of the crystalline stratified rocks.*

ɩeserving for another occasion the discussion of their mode ormation, I propose at the present time to describe and give results of my examinations of some of the so-called serpen- -rocks of the Green Mountains. The following pages are ed from the recently published Report of Progress of the logical Survey of Canada, for the years 1853–1857, pp. 432– . The same volume contains the results of the chemical mineralogical examinations of various diallages, diorites, ıet-rocks, talcs, chlorites, dolomites, magnesites, etc., from formation just noticed. In addition to these, will be found description of an analogous series of rocks from the Lauren- system, where the serpentines, dolomites, euphotides, dio- ;, etc., are repeated with certain differences, offering an in- ctive parallelism with the corresponding Silurian series, and wing that the chemical conditions during the deposition of oldest known sedimentary rocks were similar to those which ɤailed during a portion of the Lower Silurian period, and

Sec this Journal (2), vol. xxiii, p. 437, Proceedings of the Royal Society for 7, 1857, and the Report of the Geological Survey, cited below, p. 477.

have since been repeated many times in the world's geological history. The materials of this report may furnish the subject of farther communications.

The mineral species serpentine is a hydrated silicate of magnesia, whose composition according to the received formula is represented by silica 43·7, magnesia 43·3, water 13·0 = 100·0; a portion of protoxyd of iron, sometimes amounting to ten per cent, generally replaces an equivalent quantity of magnesia.

The rocks known as serpentines are however variable in their constitution, being sometimes composed almost entirely of the silicate just mentioned; at other times this is mingled with other silicates, such as garnet, diallage or hornblende, with quartz, or with carbonate of lime, dolomite or carbonate of magnesia. Mineralogists have therefore distinguished these rocks by the general names of *ophiolite* and *ophicalce*. Thus we have, besides a rock which is composed essentially of serpentine, and may be regarded as the *common* or *normal ophiolite*, varieties characterized by admixtures of garnet, diallage, hornblende and chromic iron ore, which may be respectively designated as *grenatic* or *garnetiferous*, *diallagic*, *hornblendic* and *chromiferous ophiolites*; to these we must add the *quartzose ophiolite* of Brongniart, which is composed of nodules of quartz in a base of serpentine. The *gabbro* of the Italian geologists is a diallagic ophiolite.

The name of *ophicalce* has been given by Brongniart to rocks composed essentially of carbonate of lime and serpentine or talc. Crystalline limestones which hold disseminated grains of serpentine, are designated by him as *granular ophicalce*, while under the name of *reticulated ophicalce* he has described an aggregate of rounded masses of carbonate of lime, cemented by a base of talcose serpentine. In addition to these, the same author describes an aggregate of rounded masses of quartz, green jasper and silicious slate, cemented by serpentine, and several breccias, consisting of angular fragments of quartz, of serpentine, and of jasper, in a paste of serpentine. These rocks he separates from the preceding species under the name of *anagenites* and *breccias*. But such aggregates, in which serpentine is sometimes the paste, and sometimes the imbedded mineral, cannot be separated from certain varieties of ophicalce. Again, in this last species, the calcareous matter is often replaced by dolomite, and even by crystalline carbonate of magnesia, forming varieties of rock to which the name of ophicalce is no longer appropriate. I therefore propose to unite all these varieties under the general name of ophiolite, and to describe them as *calcareous*, *dolomitic* and *magnesitic ophiolites*, which may be granular, gneissoid, conglomerate, or brecciated in their structure. I have been thus particular in distinguishing these different varieties, because they have doubtless a common origin, and because their study will

aid us in getting an idea of the mode of formation of serpentine rocks.

The ophiolites of the Green Mountains often contain diallage, and more rarely actinolite and garnet. Calcareous, dolomitic and magnesitic varieties are common, and are granular, gneissoid, and sometimes conglomerate in their structure. Small portions of nickel and chrome are seldom or never wanting in these rocks, which often contain grains and even beds of chromic iron. Foliated and fibrous varieties of serpentine are also met with there, constituting the varieties which have been named *baltimorite*, *picrolite* and *chrysotile*. A fine collection of ophiolites from the township of Orford, where these rocks are very extensively displayed, has furnished me with a large number of the specimens about to be described.

The analysis of the serpentines was generally effected by treating the mineral in fine powder with sulphuric acid diluted with its own volume of water, and heating the mixture in a platinum capsule until acid fumes were evolved; it was sometimes necessary to repeat this process with the undissolved residue.

The purity of the separated silica was in all cases determined by dissolving it with the aid of heat, in a solution of carbonate of soda. The action of a boiling solution of nitrate of ammonia upon the mineral, either before or after ignition, was generally had recourse to for the determination of any earthy carbonates which might be present.

1. *Normal Ophiolite.*—A very beautiful and homogeneous variety of serpentine rock from the tenth lot of the eighteenth range of Orford, was found to have a density of 2·597. It was finely granular in texture, and had a scaly conchoidal fracture; color deep olive-green, with small bluish veins; it was sub-translucent, and had a highly argillaceous odor. This serpentine holds in very small quantity, disseminated grains of magnetic and chromic iron ores, and contains a little nickel, but no cobalt. When ignited and boiled with a solution of nitrate of ammonia, it gave a trace of magnesia, but no lime. Its analysis yielded:—

Silica,	40·30
Magnesia (by difference),	39·07
Protoxyd of iron,	7·02
Oxyd of nickel,	·26
" " chrome,	(traces.)
Water, by ignition,	13·35
	100·00

2. A fragment of pure serpentine from a conglomerate dolomitic ophiolite about to be described, had a density of 2·622, a blackish-green color, a conchoidal fracture, and was almost opaque. The pulverized and ignited mineral yielded to nitrate of ammonia, 0·40 of carbonate of lime and 0·27 of carbonate of

magnesia. This serpentine contains a small quantity of chromic iron. The oxyd of nickel, determined upon four grams of the mineral, gave no trace of cobalt before the blowpipe. Its analysis gave as follows:—

Silica,	42·90
Magnesia,	36·28
Protoxyd of iron,	7·47
Oxyd of nickel,	·15
Chromic iron,	·25
Loss by ignition,	13·14
	100·19

3. I may cite in this place the analysis of a serpentine given in my Report for 1852, p. 99. It forms the rock in contact with the bed of chromic iron ore in Ham, has a hardness of 3·5, and a density of 2·546. It is massive and compact, with a splintery fracture; color greenish-white, and translucent. The analysis, which failed to detect either chrome or lime, gave as follows:—

Silica,	43·4
Magnesia (by difference),	40·0
Alumina and oxyd of iron,	3·6
Water,	13·0
	100·0

The associated chromic iron ore gave by analysis 0·22 per cent of oxyd of nickel, which, fused with borax before the blowpipe, afforded distinct evidence of the presence of cobalt.

4. A characteristic fibrous serpentine (*picrolite*) from the seventh lot of the eighth range of Bolton, has a hardness of 4, and a density of 2·607. It breaks into ligneous masses several inches in length; very compact; fracture splintery; fibres stiff and elastic; shows an oblique cleavage. Color celandine-green; lustre vitreous, silky; transparent in small fragments; tough, and difficult to pulverize. The finely-sifted powder is completely decomposed by sulphuric acid, and the silica retains the form and lustre of the fibres; the mineral contains apparently as much nickel as 1. Its analysis gave:—

Silica,	43·70
Magnesia,	40·68
Protoxyd of iron,	3·51
Oxyd of nickel (undetermined).	
Water,	12·45
	100·34

5. *Calcareous Ophiolite.*—The specimen of this variety which I have analyzed is from the tenth lot of the sixteenth range of Orford. It is fine grained and sub-crystalline, with a scaly, somewhat conchoidal fracture. Color, mottled greenish-grey,

an occasional purplish tinge. Translucent on the edges, resembles, except in color, many common limestones. In ler, the rock effervesces with acetic acid, even in the cold, by the aid of heat fifty-seven per cent of the mass were dis-ed, consisting of carbonate of lime with a little magnesia a trace of iron. The residue effervesced in the cold with e nitric acid, whose action, aided by a gentle heat during an-hour, dissolved 10·76 per cent of carbonate of lime and nesia, with a little iron, corresponding to a ferriferous dolo- . The pale-green residue from the action of the nitric acid, 1 dried at 212° F., equalled 32·00 per cent. It was readily mposed by sulphuric acid, without any effervescence, and the characters of serpentine. Its analysis gave:—

Silica,	41·20
Magnesia,	32·16
Protoxyd of iron,	11·16
Lime,	·65
Alumina,	2·67
Water,	12·70
	100·54

ıe portion soluble in acetic acid (I.) and that dissolved in c acid (II.) had the following composition for 100 parts:—

	I.	II.
Carbonate of lime,	91·33	49·45
" " magnesia,	8·67	43·68
" " iron,	(traces)	6·87
	100·00	100·00

will be seen that the dilute acids attack but slightly the entine, and that the nitric acid dissolves an intermingled mite, which is but little acted upon by the acetic acid. I taken advantage of this reaction to separate the dolomite the carbonate of lime in a crystalline magnesian limestone, se analysis is given in my Report for 1854. The proximate ysis of the rock in question shows it to be a mixture of car-ıte of lime, dolomite and serpentine, and we have for 100 s:—

Soluble in acetic acid,	57·00
" " nitric acid,	10·76
Insoluble, serpentine,	32·00
	99·76

Dolomitic Ophiolite.—This granular variety is from the e of Brompton Lake, in the seventh range of the thirteenth f Orford. It is fine grained and greyish-green like the last, somewhat darker in color, and weathers reddish-brown. Its ure is uneven and sub-conchoidal, presenting grains of a

crystalline spar. A fibrous coating is sometimes apparent in the joints of the rock. Its hardness is about 4. When reduced to powder it did not effervesce with acetic acid like the last, but was readily attacked by dilute nitric acid, which removed carbonates of lime, magnesia and iron, with effervescence, leaving a residue of serpentine. A proximate analysis gave 51·9 parts of serpentine, and 48·1 of dolomite = 100·0. The nitric solution contained some manganese and nickel.

The composition of the serpentine left by the nitric acid was:—

Silica,	43·20
Magnesia (by difference),	36·11
Protoxyd of iron with nickel,	8·29
Water,	12·40
	100·00

The dolomite dissolved, gave for 100 parts:—

Carbonate of lime,	49·58
" " magnesia,	46·32
" " iron with manganese,	4·10
	100·00

7. *Dolomitic Ophiolite.*—This rock, also from Brompton Lake, on the twelfth lot of the eighteenth range of Orford, has furnished some fine blocks for ornamental purposes. It is a conglomerate, made up of fragments of serpentine thickly disseminated in a greenish-white dolomitic base. The masses of serpentine vary from a line to more than an inch in diameter, and although rounded, are more or less angular in form. Their colors are various shades of dark green, sometimes appearing nearly black when polished. The analysis of one of these imbedded masses has already been given (No. 2). This rock contains both nickel and chromic iron.

An average specimen of the conglomerate was pulverized for examination. The powder effervesced even in the cold, with acetic acid, which with the aid of heat, took up by prolonged digestion, twenty per cent of carbonates of lime and magnesia, and 0·2 of oxyd of iron. The soluble portion contained carbonate of lime 88·30, carbonate of magnesia 11·70. The residue from acetic acid effervesced slightly with warm dilute nitric acid, and the solution was found to contain a quantity of magnesia equivalent to 5·68 per cent of the original mass (11·70 per cent of magnesian carbonate), besides 1·36 of peroxyd of iron and 0·60 of alumina, but no lime, the whole of that base having been removed by the acetic acid. The residue from the action of nitric acid, was decomposed by fusion with carbonate of soda, and gave:—

Silica,	45·10
Magnesia, (by difference),	34·68
Protoxyd of iron,	6·12
Alumina,	·80
Water,	13·30
	100·00

This residue when ignited, yielded but a trace of magnesia to a boiling solution of nitrate of ammonia, showing that it retained no carbonate; but from the excess of silica it was evident that a partial decomposition of the serpentine had been effected by the nitric acid. In confirmation of this, I found that a second portion of the pulverized rock, when submitted to a prolonged digestion with acetic acid, left 75·5 per cent of matter dried at 212° F.; this residue gave a feeble effervescence with nitric acid, which by prolonged digestion, took up 18·0 per cent of magnesia, although when previously ignited, the residue gave to a solution of nitrate of ammonia only a trace of lime, and but 0·3 per cent of magnesia. Its analysis by fusion with carbonate of soda gave:—

Silica,	43·10
Magnesia,	35·52
Protoxyd of iron,	8·32
Water,	11·90
	99·34

Another specimen of the conglomerate was now pulverized, and eight grams of it were digested for a long time with boiling acetic acid; the insoluble residue, after levigation, was subjected a second time to the same treatment. The matters thus dissolved for 100 parts of the mineral, were:—

Carbonate of lime,	7·35
" " magnesia,	7·72
" " iron,	1·78
	16·85

A portion of the residue from the acid was ignited and boiled with nitrate of ammonia, which dissolved a portion of lime equal to 0·3 per cent of carbonate, and of magnesia equal to 3·26 of carbonate of magnesia; making a total of 10·98 of carbonate of magnesia to 7·65 of carbonate of lime. The serpentine residue, still containing these 3·56 per cent of carbonates, gave by analysis with carbonate of soda, the following results:—

Silica, (by difference),	43·93
Magnesia,	35·64
Protoxyd of iron,	7·83
Lime,	(traces.)
Loss by ignition,	12·60
	100·00

A portion of the powder of this last specimen of the conglomerate was ignited for ten minutes over a spirit-lamp, and then boiled with a solution of nitrate of ammonia, so long as a perceptible odor of ammonia was evolved; there were dissolved by this means 6·50 per cent of carbonate of lime, and 7·65 of carbonate of magnesia.

Veins of from four to six lines in breadth are often met with in this conglomerate. Their walls are covered with a thin layer of pale green serpentine, having a fibrous structure perpendicular to the sides of the vein; upon this is deposited a bluish-white fine grained dolomite, while in the middle a nearly pure cleavable calcite occurs. The analysis of a portion of this dolomite gave:—

Carbonate of lime,	59·32
" " magnesia,	34·15
" " iron,	4·83
	98·30

8. *Magnesitic Ophiolite.*—In the three preceding specimens we have examples of ophiolites which are mixtures of serpentine with carbonates of lime and magnesia; in the first the lime is greatly in excess, in the second the two carbonates are united in the proportions required to form a dolomite, while in the third the magnesian carbonate predominates, but from the action of cold acetic acid, it would appear that a portion at least of the carbonate of lime in this specimen, is not in chemical combination with the magnesian carbonate. The history of these rocks would however be incomplete without the description of another variety, in which the carbonate of lime is entirely wanting, and which consists wholly of silicates and carbonates of magnesia and iron. This remarkable rock has not yet been noticed in Canada, but is found in Vermont, in the southern prolongation of the Green Mountains, and constitutes the so-called serpentine marble of Roxbury in that state; it has been examined by Dr. C. T. Jackson and Dr. A. A. Hayes of Boston.

Dr. Jackson (this Journal, [2], vol. xxiii, p. 125,) succeeded in separating from the rock a mineral having the composition of serpentine, and describes veins composed of ferriferous carbonate of magnesia, and others of ferriferous dolomite, which traverse the mass. According to Dr. Hayes, (ibid, [2], vol. xxi, p. 382,) the rock is an aggregate of fibrous and compact asbestus, talc, chlorite and chromic iron, with angular fragments of talc-schist and argillite, the whole cemented by carbonate of magnesia, which forms according to him, on an average, 38 p. c. of the mass. He has also shown that the ophiolites of Cavendish, and of Lynnfield in the same region, contain carbonate of magnesia, without any lime. Through the kindness of the above-named

gentlemen, I have been furnished with a series of specimens, which have permitted me to make a careful examination of the Roxbury ophiolite.

Some portions of the rock appear as a mottled granular mass, having a hardness of about 4·0, with an uneven fracture, and presenting cleavable grains of magnesite; the colors vary from blackish-green to greenish-white, and the rock is susceptible of a high polish. Other specimens are white and crystalline, with numerous greenish-grey bands, the whole arranged in parallel layers, as if stratified, and resembling closely some varieties of gneiss. The rock cleaves with these layers, which contain serpentine and talc, intermingled with carbonate of magnesia. This mineral, as described by Drs. Jackson and Hayes, is nearly pure in the white portions, and has a hardness of 4·0, and a density of 2·99—3·00, according to my determinations. Dr. Hayes found for its composition, carbonic acid 48·80, magnesia 45·60, talc and a little silica 3·60, silicate of protoxyd of iron 1·96 = 99·96.

This result corresponds closely with my own. I obtained from 100 parts, 2·76 of talc, and 1·82 of silica, besides 2·40 of peroxyd of iron, corresponding to 3·48 of carbonate of iron, the rest being carbonic acid and magnesia, with a little manganese. The greater portion of the iron exists here as carbonate, as is evident from the fact that it is dissolved by a boiling solution of nitrate of ammonia; but there is also present a portion of silicate of iron and magnesia, decomposed by acids. In my analysis the powdered magnesite was digested for a long time at a boiling heat with hydrochloric acid; the insoluble portion was then boiled with strong sulphuric acid, and from the residue the silica was removed by a solution of carbonate of soda, the talc remaining.

The talc thus purified from magnesite and serpentine by successive treatments with hydrochloric and sulphuric acids and carbonate of soda, was gently ignited, and then decomposed by fusion with carbonate of soda; it gave:—

Silica,	62·60
Magnesia,	31·30
Alumina and oxyd of iron,	4·06
Water and loss,	2·04
	100·00

In the analysis of Dr. Hayes just cited, the 48·80 parts of carbonic acid are sufficient only for 44·36 parts of magnesia, leaving 1·24 of this base in the form of a silicate decomposable by sulphuric acid. In order to determine the composition of this silicate, a dark-green portion of the rock was pulverized, and boiled for a long time with dilute nitric acid, which dissolved

a large amount of magnesia with disengagement of carbonic acid; the solution contained besides, magnesia, iron, manganese, and a trace of nickel, but no lime. The undissolved residue was then boiled with a solution of carbonate of soda, which took up a considerable amount of silica derived from the silicate which had been partially decomposed by the nitric acid, and left a dense granular matter, mingled with silvery scales of greenish talc, which were in great part removed by washing. The denser silicate was then dried at 250° F., and submitted to analysis. By ignition it lost 11·40 per cent, and then gave to a boiling solution of nitrate of ammonia a quantity of magnesia equal to 1·21 of carbonate. Another portion was decomposed by sulphuric acid, and the silica separated from the insoluble talc by a solution of carbonate of soda. The results of the analysis were as follows:—

Silica,	39·60
Magnesia,	36·72
Protoxyd of iron,	4·86
Oxyd of nickel,	(traces.)
Talc,	6·80
Water,	10·77
Carbonic acid,	·63
	99·38

Deducting the talc, the carbonic acid, and the amount of magnesia required to form with it 1·21 of carbonate, we have for the composition of this silicate dried at 250° F.:—

Silica,	43·24
Magnesia,	39·65
Protoxyd of iron,	5·32
Oxyd of nickel,	(traces.)
Water,	11·79
	100·00

This is the composition of serpentine, and the ophiolite of Roxbury is thus shown to consist of serpentine and talc, intermixed with a ferriferous carbonate of magnesia; the compact asbestus of Dr. Hayes is nothing more than serpentine.

In the second part of this paper I propose to describe among others, some of the ophiolites of the Laurentian series.

ART. XXI.—*The Chalchihuitl of the ancient Mexicans: its locality and association, and its identity with Turquois;* by W. P. BLAKE.

THE Navajo Indians in the northern and western portion of New Mexico wear small ornaments and trinkets, fashioned out of a hard, green, stone which they call *Chalchihuitl.** It is esteemed among them as a gem of very great value, holding a rank equal to that of the diamond with us. It is more highly prized than gold, and is often used in trade among themselves, a string of fragments large enough for an ear-ring being worth as much as a mule. Few or none of these stones are obtained by strangers, for they are never disposed to give for them what the Indians require.

The descriptions of this stone led me to regard it as Turquois, and learning that it was yet procured in small quantity by the Indians from a mountainous district not over twenty miles from Santa Fé, I visited the locality and collected several specimens.

The mountains form a group of conical peaks and are known as *Los Cerrillos.* They are southeast of Santa Fé, and north of the Placer or Gold mountains, from which they are separated by the valley of Galisteo river. The rocks of which they are composed are yellow and gray quartzose sandstones, and porphyry in dykes. The sandstones are probably of the age of the Carboniferous, and are much uplifted and metamorphosed, so that their sedimentary character is in great part obliterated.

On reaching the locality I was struck with astonishment at the extent of the excavation. It is an immense pit with precipitous sides of angular rock, projecting in crags, which sustain a growth of pines and shrubs in the fissures. On one side the rocks tower into a precipice and overhang so as to form a cave; at another place the side is low and formed of the broken rocks which were removed. From the top of the cliff, the excavation appears to be 200 feet in depth and 300 or more in width. The bottom is funnel-shaped and formed by the sloping banks of the debris or fragments of the sides. On this debris, at the bottom of the pit, pine trees over a hundred years old are now growing, and the bank of refuse rock is similarly covered with trees. This great excavation is made in the solid rock, and tens of thousands of tons of rock have been broken out. This is not the only opening; there are several pits in the vicinity, more limited in extent, some of them being apparently much more recent.

Traces of the *Chalchihuitl* were found among the broken rocks, but almost every fragment of large size and good color had

* This name is now pronounced *chal-che-we-te* by the Indians, and *char-che-we-te* by some of the New Mexicans. The Indian pronunciation is preferred.

been carefully collected. A recent heavy shower had, however, brought many small pieces of the mineral in view on the surface, and other specimens were procured by breaking open the rocks.

The specimens present in color various shades of apple-green and pea-green, passing into bluish-green. Some fragments having a blue color were found, but these are not so dense and hard as the green. Some of the specimens very closely resemble crusts or coatings of chrysocolla both in fracture and color; differing, however, very essentially in the hardness. Some of the bluish specimens are very soft and earthy, and appear to be the result of partial decomposition of the green portions by long exposure. One of the compact green fragments has been successfully cut by a lapidary; it takes a fine polish, and has a pleasing color and lustre suitable for jewelry. The hardness is a little less than that of feldspar, and the specific gravity varies from 2·426 to 2·651, the compact, green fragments giving the highest numbers.

Before the blowpipe, it fuses with intumescence on the thin edges only; in other respects, the reactions are similar to those of turquois. An analysis of it for me by J. M. Blake of the Yale Analytical Laboratory shows it to be nearly identical with turquois in composition, being a hydrous phosphate of alumina and iron, colored with oxyd of copper.

The fragments which were picked up do not exceed three quarters of an inch in length and one quarter of an inch in thickness. They appeared to have formed crusts upon the surfaces of fissures or cavities in the rock, or to have extended through it in veins. It was so found in the rock, ramifying in various directions in seams from the thickness of a card to three tenths of an inch or more. It is not accompanied, so far as could be ascertained, by any minerals, except in some cases by peroxyd of iron and a little quartz, the former being apparently the result of the decomposition of pyrites. The seams in the rock are compact and homogeneous, and the mineral adheres closely to the walls on each side. It is therefore difficult to break out fragments of large size. In some places the mineral does not form a continuous seam or crust, but is implanted in irregularly circular spots, or reniform masses along the walls of the fissures. At one of the openings most distant from the ancient excavation, it occurs in small, irregular nodules, in cavernous portions of the rock where there is much peroxyd of iron. It is occasionally seen isolated and completely enveloped in the body of the rock, but near either a fissure or a cavity. In all cases it is compact and without any trace of crystalline structure, breaking with a smooth conchoidal fracture. Several of the specimens are nearly identical in appearance with the turquois from Steine in Silesia, for a fragment of which I am indebted to Prof. G. J. Brush.

On breaking open one of the dark green fragments a small cavity was found in the centre, like the interior of a geode, with the color gradually shading into white. The interior surface is smooth and finely mamillated, reminding one of the inner surface of nodules of chalcedony. There are not any distinct layers as in agate but the color gradually diminishes from the surface to the center. A variation in the amount of the coloring matter in different specimens according to the circumstances of formation is thus indicated, and it is seen that the composition of the mineral cannot be regarded as constant. This variation of color, and the structure, indicate an origin, or formation, similar to that of chalcedony and agate,—a deposition in thin layers from either a vapor or liquid.

There did not appear to be any principal vein or well defined deposit of the mineral; it is apparently distributed in thin seams through a great body of the rock. It is possible that there is a large vein or seam covered from view by the debris. The rock is a granular porphyry, yellowish, gray and white, in color; porous and earthy in texture. It decomposes rapidly by weathering, and very much resembles a sandstone. Veins of copper pyrites associated with gold, and veins of argentiferous lead occur in the same mountains, but there are no indications of ores at the locality. The sides of the pits were carefully examined to determine whether it was possible that the excavation had been in part made for ores or the precious metals, but it was evident that the chalchihuitl was the only mineral which had been sought for.

The evident antiquity of this excavation, and its extent, renders it peculiarly interesting. Little or nothing appears to be known of it in that region, and I am not aware that it has ever been visited except by the Indians and New Mexicans. It seems hardly possible that such an amount of rock could have been removed by men without the aid of powder and machinery. The evidences were, however, conclusive that it was the work of the aborigines long before the conquest and settlement of the country by the Spaniards. It does not appear that anything has been done in the great pit for a long time. This is shown not only by the pine trees growing in it, but by the lichen-covered sides, and by the piles of rock, gray with age, around the margin. Fragments of ancient Indian pottery can easily be found among the rocks at all of the excavations. It is said that the Indians have a tradition that eight or nine of their tribe were once suddenly buried by a fall of rocks from the side of the great pit. Since that time they have been afraid to work in it. This is probable, and it is indicated by the condition of the locality. The place is, however, occasionally visited by Indians from a distance, but their operations appear to be confined to the sur-

rounding openings, or to breaking up masses of rock which were formerly removed. The fragments which they procure are taken to one of the Indian pueblos on the Rio Grande, where the art of grinding and perforating them for beads is yet known. How this is accomplished, I could not ascertain. Two or three Indians, only, go to the locality at one time, and while there they live in the cave or recess in the face of the cliff. At one side of this there was a litter of cedar boughs, and on the other, a great accumulation of ashes, the residue of camp-fires. A more picturesque abode can hardly be imagined. The entrance fronts upon, and overlooks, the ancient excavation, with its crags and forest of pines; the broad sloping plain or plateau of Santa Fé stretches out to the north, with the lofty peaks of the Rocky Mountain chain rising above it. On the west and southwest the country is open towards the Rio Grande, the monotony of the broad plains being relieved by the Sandia or Albuquerque mountains.

On my return from New Mexico I became curious to know whether any mention of the ancient excavation or of the chalchihuitl was made by the early historians or travellers in Mexico. I was much gratified to find that the mineral is mentioned by Bernal Diaz, the companion of Cortes, and others. Bernal Diaz states that, on the landing of Cortes at San Juan de Ulloa, the ambassador from Montezuma brought presents of richly worked mantles and trinkets of gold, in addition, *four chalchihuitls* intended for the Spanish Sovereign. These, the ambassadors said, were each worth more than a load of gold.* Diaz remarks that they were a species of green stone of uncommon value, which were held in higher estimation among the Indians than the smaragdus [emerald] with the Spaniards.

Torquemada makes frequent mention of chalchihuitl and regarded it as a species of emerald. He states that the Mexicans gave the name *Chalchihuitl* to Cortes, intending thus to show their respect for him as a captain of great valor, "for Chalchihuitl is of the color of the emerald, and emeralds were held in great esteem."† Offerings of this stone were made by the Indians in the temple of the goddess Matlalcueye,‡ and it was their custom to place a fragment in the mouths of the distinguished chiefs who died. Torquemada, in recording this fact, says that these stones were emeralds but that they were called chalchihuitls by the Indians.§ When Alvarado and Montezuma played together at games of chance, Alvarado paid, if he lost, in chalchihuitl stones, but received gold if he won.‖ The Indians

* History of the Conquest of Mexico, by Bernal Diaz, Lockhart's translation, vol. i, p. 93.

† Torquemada, Monarchia Indiana, ii, p. 485.

‡ Ibid, p. 288. § Ibid, p. 521. ‖ Ibid, i, p. 402.

d that the art of cutting and polishing chalchihuitl was ht them by the god Quetzalcohuatl. Sahagun considered stone to be a jasper of a very green color, or a common ·agdus.* He remarks that they are green and opaque, and much worn by the chiefs strung on a thread around their ts, being regarded as a badge of distinction.†

ι the year 1539 Friar Marco de Niça made a journey among Indians of New Mexico, and in his narrative frequently tions green and bluish stones which were worn as ornaments hem, pendant from the ears and nose. He also mentions ıg many "*turqueses*" which there is little doubt he consid- the green stones to be. These turquoises were worn not in the ears and nose but as necklaces and girdles. They : called *Cacona* by the Indians and were obtained from the ;dom of Cevola. On arriving at this place De Niça observes "the people have emeralds and other jewels, although they :m none so much as turqueses wherewith they adorn the s of the porches of their houses and their apparel and ves- and they use them instead of money through all the coun- : Coronado, who visited Cevola in 1540, denies De Niça's :ment respecting the turquoises upon the porches of the ıes, but he obtained turquois ear-rings and tablets set with ;tones.

he emeralds, turquoises, and chalchihuitl of the different ors were doubtless one and the same mineral—the chalchi- l. There is little reason to suppose that there was more than locality; that which has been described was probably the ce of all the specimens. To supply the great demand for ı among all the tribes of New and Old Mexico, must have ired a vast amount of quarrying, fully equal to that at the lity.

ames similar to chalchihuitl, or derived from it, were com- among the ancient Mexicans and the word is doubtless of ɔc origin. It is differently written by the early historians. ıuemada gives Chalchihuitl as the Indian name but fre- ıtly writes it *chalchihuite*. Lockhart, the translator of the nar- ·e by Bernal Diaz, writes *chalchihuitls*, but says that the es were called *chalchuites* by Diaz. It is singular that De ι and Coronado do not mention this name; it would appear it was not in use in the region they visited. The mention ıe fact that the stones were called *cacona* by one of the tribes ndians renders this more probable. As the stone was recog-

Historia de la Conquista de Mexico.

Hist. de Nueva España, lib. ii, cap. 8.

See Extracts from the Journal of Friar Marco de Niça, published in the Indian rt by Lieut. A. W. Whipple, Pacific R. R. Explorations and Surveys, vol. iii, 3–107.

nized as identical with turquois by these travellers, it is possible that they neglected to give the Mexican name. It is also possible that this name originated in Mexico and not among the tribes near the locality, although it is now in use there. It is desirable that this ancient name should be retained and I suggest that this New Mexican variety of turquois may be appropriately known among mineralogists as *chalchihuitl*.

ART. XXII.—*On a method of Preparing and Mounting Hard Tissues for the Microscope;* by CHRISTOPHER JOHNSTON, M.D.

HAVING for several years occupied my leisure moments with what are usually denominated "microscopical studies," I beg leave to offer, as the result of successful experience, a simple and certain method of preparing and mounting *hard tissues*, such as bone, teeth, shells, fossilized wood, &c.

I am aware that treatises upon the microscope give a few indications for making sections and embalming them in Canada balsam; but they are unsatisfactory either by reason of their brevity or their want of precision. Specimens may be procured ready-made from the hands of Topping, Bourgogne and others, but while they are expensive, persons in remote situations are obliged to purchase by catalogue without the opportunity of selection. Besides, it is oftentimes difficult or else impossible to obtain series of particular objects; so that the student must either limit his researches or "prepare" for himself: in the latter case he may increase his number of objects indefinitely, and supply himself with many such as are not attainable from abroad, and divided in any direction he may require.

A microscopic section should be as thin as the structure of the object will allow, of uniform thickness, and polished on both sides, whether it be mounted in the dry way or in balsam. To meet these requirements I proceed as follows:—

Being provided with

1. A coarse and a fine 'Kansas hone, kept dressed *flat* with fine emery;
2. A long fine Stub's dentist's file;
3. A thin dividing file and fine saw;
4. Some Russian isinglass boiled, strained, and mixed with alcohol sufficient to form a *tolerably* thick jelly when cold;
5. A small quantity of Canada balsam;
6. Slides; 7. Cover glass;
8. One ounce of chloroform; 9. One of F.F. aqua ammonia;
10. Some fragments of thick plate (mirror) glass 1 inch square or 1 by 2 inches; and finally,

1. An ounce of "dentist's silex," and
2. Thin French letter paper, of which 500 or more leaves are uired to fill up the space of an inch: I examine the object . decide upon the plane of the proposed section.

'oarse approximative sections may be obtained with the saw lividing file (excepting silicified substances), but these instru- ıts are not applicable to longitudinal sections of small human other teeth, small bones, &c. Take now the object in the gers if sufficiently large, and grind it upon the coarse hone h water, to which add "silex" if necessary, until the surface ncides with the intended plane. Wash carefully: finish upon finer hone; and polish upon soft linen stretched upon a oth block.

f the object be too small to admit of immediate manipulation hould be fastened upon a piece of glass with isinglass—or it is better, upon thin paper well glued with the same sub- ıce upon glass; and a piece of thick paper or visiting card, forated with a free aperture for the object, must be attached he first paper. This is the *guard*, down to which the speci- ı must be ground with oil: and its thickness and the disposal the object require the exercise of good judgment. Hot water . release everything; and chloroform remove the grease from specimen, which, like that ground with water, is ready for second part of the process.

d. Carefully cover the surface of a piece of the plate glass ı thin French letter paper; next apply a paper *guard*, as be- stated, but not thicker, for teeth and bone, than $\frac{1}{500}$th inch; ı trace a few lines with a lead pencil upon the first paper in little space left in the *guard* so that the increasing transpar- y of a specimen being prepared may be appreciated; and lly moisten the "space" with isinglass to the extent of the ect, which must be delicately brushed over on the ground ace and at the *edges* with tolerably thin isinglass before it is ented in its place. Gentle pressure should now be employed, maintained with a wire spring, or thread wound round about. n two or three hours the second side may be ground in oil; x may be employed at first, or even a file; but these means st not be persevered in, and the operation must be completed n the bare hone. When the second side shall have been ed with chloroform it may be polished with a bit of silk n the finger; and after *spontaneous* separation from the paper hot water the specimen ought to be well washed on both s with a camel's hair pencil and soap water, dropped into l water, and thence extracted to dry. After immersion in oroform for a moment, and examination for the removal of sibly adherent particles, the *section* may be declared suitable mounting.

Before proceeding to this step, a few precautions are necessary about particular sections. Transverse sections of teeth or bone should be dried, after the preliminary washing, between glass, in order to avoid the disadvantage of warping. Very porous parts, such as cancellated bone, or fragile bodies, such as the poison fang of serpents, require that the whole structure, or the canals, be saturated with glue and dried. Sections may now be cut with a saw, ground in oil, and cemented to the holding-glass subsequent to immersion in chloroform.

Mounting.—Spread a sufficient quantity of old Canada balsam, or of that thickened by heat (not boiling), upon a slide, and, when cold, impose the section. Have ready a spatula bearing a quantity of equally inspissated balsam warmed until it flows, with which cover the specimen, and then immediately warm the slide, being careful to employ the least possible heat. Now carefully depress the section and withdraw every air bubble with a stout needle set in a handle towards the ends of the slide: put on the cover glass, slightly warmed, not flat, but allowing one edge to touch the balsam first, press out superfluous balsam, and the specimen is safe. The slide may now be cleaned with a warm knife, spirits of wine, and ammonia.

This communication would be incomplete without some very important hints concerning "cover glass." It is easy to clean small covers, but very thin glasses or large ones, one or two inches in length, are not so safely handled. All danger of breaking is, however, avoided by placing a cover upon a large clean slide, and wiping one side only with a bit of linen damp with aqua ammonia, and then with a dry piece. The other side may be cleaned after the mounting.

In the next place, all preparers are aware of the difficulty attending the use and application of large covers. I beg leave to assure the inexpert that the following method will insure success. Having prepared the cover glass and superposed it, let it first be gently pressed downwards at many points with the flat end of a lead pencil: it will be found, however, almost impossible to flatten it without breaking, consequently too much balsam will overlie and underlie the section. Let now a piece of thin paper be laid over the cover and upon this a thick slide; if a moderate heat be applied to both the slides, over and beneath the specimen, direct pressure evenly exerted with the fingers (or spring clothes-pins) will force out all unnecessary balsam, and leave the section and the protecting cover perfectly flat and unbroken.

The reader will not deem me too prolix when he attempts his first preparation, or when, after having followed the plans so scantily given in the books, he feels the need of something precisely definite. It is certain that neither Canada balsam nor gum mastic will retain the first ground side of a specimen upon

ı slide long enough to enable the preparer to reduce it to the 'equisite thinness, and with both these substances *heat* must be ımployed, which is objectionable because most objects are hereby warped or cracked; and furthermore the paper *guard*, which I hold to be indispensable for limiting and equalizing the hinness of a section, is not mentioned in treatises, in which, if known to the author, such a measure should be noticed. But t is possible to fasten agate, fossil wood, &c. with hot gum shelac, so that they may be ground upon both sides with a water stone; but even in these instances invidious cracks may endanger or destroy the beauty of a choice preparation.

I am confident that my specimens are second to none in any 'espect: and the highly creditable performances of friends, to whom I have given the method forming the subject of this communication, lead me to believe that with the facilities it affords he observers of our country will need no Topping for objects within their reach, and I beg leave to add that the profitable pleasure I have enjoyed induces me, through the American Journal of Science, to invite participation.

Baltimore, Nov. 15th, 1857.

ART. XXIII.—*Blodget's Climatology of the United States and of the Temperate Latitudes of the North American Continent.**

THIS work relates to a subject of great practical importance o the people of the United States, and one which hitherto has eceived but partial attention. In 1842 there was published a volume on "the Climate of the United States and its endemic nfluences, by Samuel Forry, M.D." This was an octavo volume of 380 pages, more than two-thirds of which were devoted to an pplication of the laws of climate to the elucidation of disease. The general subject of the climate of the United States was herefore treated in a very brief manner, and the materials for xtending the investigation much beyond the Mississippi Valley vere very imperfect.

The work of Mr. Blodget contains a summary of the statistics of Meteorological Observations, furnishing the mean temperature of each month at 250 stations scattered all over the United States,

* Climatology of the United States and of the temperate latitudes of the North American Continent, embracing a full comparison of these with the Climatology of the temperate latitudes of Europe and Asia, and especially in regard to Agriculture, sanitary investigations and Engineering, with Isothermal and Rain Charts for each season, the extreme months and the year, including a Summary of the Statistics of meteorological observations in the United States, condensed from recent scientific and official publications. By LORIN BLODGET. 536 pp. large 8vo, with maps. 1857. Philadelphia, J. B. Lippincott & Co.; London, Trübner & Co.

and at 150 stations for other portions of the northern hemisphere; also the average amount of rain for each month at 200 stations in the United States, and more than 50 stations on the Eastern continent. It contains an outline of the Physical Geography of the United States; it describes the general character of the climate of the Eastern United States; as also that of the interior and of the Pacific coast; it institutes a comparison between the arid and interior areas of the two continents; between the Eastern United States and the West of Europe, and also a comparison between the basin of the Gulf of Mexico and that of the Mediterranean sea. It describes the distribution of heat in the United States, for each month and for the four seasons, and a comprehensive summary of the results is presented in a series of isothermal charts. It describes the distribution of rain, for each of the four seasons, and also for the entire year, and the results are exhibited upon a series of rain charts. It notices the winds and the winter storms, together with the hurricanes of the United States. It discusses the relations of climate to vegetation, particularly to the grand staples of the United States, Indian corn, sugar cane, cotton, wheat, etc. It treats briefly of the dependence of disease upon climate; and discusses the question of the permanence of climate. It is seldom that we find introduced into a single volume such a variety of topics, calculated to interest the great mass of an intelligent community. The author moreover assures us that "*no part of this work is the result of hasty or superficial discussion*, and that all the steps of analytical investigation and detailed criticism required for such a purpose as that of constructing an approximate climatology have been taken in advance." We could not ask for stronger assurance than this, and we address ourselves to an examination of the work in the confident expectation of finding much new light shed upon many subjects which have been hitherto but imperfectly understood.

The distribution of temperature in the United States is shown to be extremely irregular, and the isothermal lines pay very little respect to parallels of latitude. Throughout the whole country east of the Mississippi, these irregularities are less remarkable, and the position of the lines of equal temperature is substantially the same as has been long since assigned them; but between the Mississippi and the Pacific Ocean lies a territory which until recently was almost wholly unexplored. The publication of the Army Meteorological Register in 1855, furnished materials which indicated the most prominent features of the climate of this region. We will mention briefly a few of the most important facts brought to light by the publication of the Army Meteorological Register and the Climatology of Mr. Blodget.

1. In latitude 33°, within 150 miles of the Pacific coast, is a district whose mean temperature during the three months of summer is 90°. This is shown by the observations at Fort Yuma. Fort Yuma is situated on the west bank of the Great Colorado, eighty miles from the Gulf of California in latitude 32° 43′, and longitude 114° 36′. The locality is a rocky bluff, 75 feet above the river, and 120 feet above the sea, with sand hills and rocky bluffs bordering the wide valley, and connecting with an immense sand desert on the west. The following are the results of three years observations.

	Mean temperature of				Mean of 3 summer months.	Maximum temp'ture.
	June.	July.	August.	Sept.		
1852	87·00°	88·65°	88·10°	83·55°	87·92°	108°
1853	89·49	94·12	92·16	89·33	91·92	121
1854	85·40	94·05	90 62	85·48	90·02	113
Mean	87·29	92·27	90·29	86·12	89·95	

In order to appreciate the importance of this result, we must compare it with observations made in other parts of the world. *From no other station on the American continent do we find observations indicating a mean temperature for summer so high by more than two degrees.* On the Eastern continent a few instances of higher temperature are recorded. Professor Dove has furnished us the mean temperature of nearly 1000 stations scattered all over the globe, and among these the following are the only instances which furnish a mean summer temperature as high as 90°.

	Latitude.	Longitude.	Mean temperature of				3 Summer months.	No. of years.
			June.	July.	August.	Sept.		
Pondichery, ...	11° 56′ N.	79° 52′ E.	95° 40	93°·80	92°·00	89°·50	93°·73	1
Bagdad, ...	33 21 N.	44 22	92·08	93·20	94·10	87·35	93·13	1
Upper Egypt, ...	26 0 N.	33 40	90 50	94·44	91·06	86·56	92·02	1
Abusheher, ...	28 15 N.	50 54	89·78	93 74	92·48	88·52	92·01	1
Mosul, ...	36 19 N.	43 10	87·10	94·10	90·64	80·98	90·61	1

At each of these stations the observations embrace only a period of one year, and it is not improbable that the results would be somewhat reduced by observations continued for a longer period. In conclusion we find that Fort Yuma is the hottest place at present known on the Western continent, and is exceeded by only a very small portion of the Eastern continent.

2. The mean temperature of the coast of California during summer, is about twenty degrees colder than at places 100 miles in the interior upon the same parallel. This will appear from the following comparison.

	On the Coast. Lat.	Long.	Summer temp.		Interior. Lat.	Long.	Summ'r temp.	Difference.
	° ′	° ′	°		° ′	° ′	°	°
Fort Humboldt...	40 46	124 9	57·4	Fort Reading	40 30	122 5	80·0	22·6
San Francisco....	37 48	122 26	57·3	Sacramento.	38 34	121 40	73·0	15·7
Monterey	36 36	121 52	58·6	Fort Miller..	37 0	119 40	85·5	26·9
San Diego.......	32 42	117 14	71·2	Fort Yuma..	32 43	114 36	90·0	18·8

3. Through about 20 degrees of latitude, the mean summer temperature of the Pacific coast is nearly constant, and indeed increases slightly in going from California to Oregon. This will appear from the following observations.

	Latitude.	Longitude.	Mean Summer temp're.	Years.
	° ′	° ′	°	
Monterey	36 36	121 52	58·6	5
San Francisco ...	37 48	122 26	57·3	4
Fort Humboldt, ..	40 46	124 9	57·4	1½
Fort Orford	42 44	124 29	59·9	2
Astoria	46 11	123 48	61·6	1
Sitka...........	57 3	135 18	54 2	7

4. The mean temperature of the California coast is nearly constant for six months of the year—from May to October,—and at some places the warmest month of the year is either May, September or October. This will appear from the following observations.

	May	June.	July.	Aug.	Sept.	Oct.	Years.
	°	°	°	°	°	°	
Monterey	56 8	57·8	58·5	59 6	59·3	58·4	5
San Francisco ...	55·3	56 8	57·9	57·2	58·3	57·9	4
Fort Humboldt...	55·3	58 6	56 7	57 0	57 0	53 0	1½

At Monterey in 1847, and also in 1850, September was the warmest month of the year; and in 1849 May was the warmest month. At San Francisco in 1853 and also in 1854, October was the warmest month of the year.

These remarkable anomalies respecting the temperature of the Pacific coast are at least in part explained by the prevalent westerly winds combined with the temperature of the neighboring ocean. The mean temperature of the ocean on the California coast in latitude 40°, during summer is 56°·5; which it will be observed is a little below the temperature of the coast stations given above.

The distribution of rain on the Pacific coast presents anomalies quite as remarkable as the distribution of temperature. At some places not a drop of rain falls for three months or more in succession, and the total fall for the year does not exceed from 3 to 7 inches; while other places are literally deluged with rain. This will appear from the following table, showing the fall of rain at sixteen stations near the Pacific coast.

[redacted]

	Lat.	Long.	Alt'e	May.	June	July	Aug.	Sept.	Oct.	Spr'g.	Sum'r	Aut'n.	Win'r	Year	[illegible]
	° ′	° ′	feet.												
Fort Yuma...	32 43	114 36	120	0·00	0·00	0·16	1·13	0·58	0·13	0·27	1·30	0·86	0·72	3·15	4
San Diego ...	32 42	117 14	150	0·57	0·15	0·01	0·39	0·03	0·05	2·74	0 55	1·24	5·90	10·43	5
San Luis Rey.	33 13	117 25	20	...	...	0·00	0·00	0·00	0·20	0·21	0·00	3·48	3 26	6·95	1
Del Chino ...	34 0	117 20	1000	1·14	0·00	0·00	0·09	0·00	0·00	4·59	0·09	1 67	7·42	13·77	2
Fort Tejon ...	35 3	118 48	1447	0·61	0·00	0·00	0·00	1·00	0·05	5·97	0·00	2·61	....	....	1
Monterey	36 36	121 52	140	0·53	0·13	0 08	0·00	0·01	0 33	4·43	0·21	1·65	5·91	12·20	4
Fort Miller...	37 0	119 40	402	1·36	0·01	0·01	0·00	0·05	0·16	9·57	0·02	2·80	9 79	22·18	4
San Francisco	37 48	122 26	150	0·48	0·02	0·00	0·01	0 07	0 63	8·81	0·03	2 75	11·25	22·84	4
Benicia.......	38 3	122 8	64	0·59	0·01	0·00	0·00	0·01	0·69	6·40	0·01	2·65	7 56	16·62	5
Sacramento ..	38 33	121 20	50	0·01	...	0·00	0·00	0·00	0·20	7·01	0·00	6 61	12·11	25 73	1
Camp Far West	39 7	120 18	150	0·86	0·00	0·00	0·00	0·36	0 06	10 66	0·00	2·40	6·79	19·85	1
Fort Humboldt	40 46	124 9	50	1·96	1·15	0·00	0·00	0·65	2·11	13·51	1·18	4 87	15·03	34·56	2
Fort Orford...	42 44	124 29	50	5·24	1·06	0·16	1·78	2·34	7·31	19·12	3·00	19·92	29 59	71·63	2
Astoria	46 11	123 48	50	5·95	2·85	0·00	1·15	1·87	6·70	16·43	4·00	21·77	44·15	86·35	1
Steilacoom...	47 10	122 25	300	1·86	1·97	0·34	1·54	2 67	4·43	11·19	3·85	15 83	22·62	53 49	6
Sitka........	57 3	135 18	20	5 29	3·79	4·15	7 81	11·.7	2·3	18·32	15·75	32·10	23·77	89 94	7

Thus it is seen that for a period of two years no rain fell at Del Chino during the months of June, July, September and October, and only $\frac{9}{100}$ inch in August; that is, only $\frac{9}{100}$ inch for five months. At San Luis Rey no rain fell during the months of July, August and September. During May and June the observations are supposed to have been suspended. At Sacramento no rain fell during July, August and September. Only $\frac{1}{100}$ inch fell in May, and during June the observations appear to have been suspended. At Fort Tejon and Camp Far West no rain fell during the months of June, July and August. At eleven of the preceding stations, we find the aggregate fall of rain for five months of the year was less than one inch, viz. at Del Chino 0·09; San Luis Rey 0·21; Sacramento 0·21; Fort Miller 0·23; Camp Far West 0·42; Monterey 0·55; San Francisco 0·58; Benicia 0·61; San Diego 0·63; Fort Tejon 0·66; Fort Yuma 0·87.

The large amount of rain at Sitka, Astoria, and Fort Orford is nearly as remarkable as the absence of rain at places farther south. On the Atlantic coast in latitude 45°, the average annual fall of rain is about 36 inches.

All the facts with reference to the distribution of temperature and rain are palpably exhibited to the eye in a series of charts, for which Mr. Blodget deserves great credit. We cannot however avoid the impression that some of the anomalies which are indicated upon these charts will disappear when we obtain the mean of observations for a longer period of years.

It would afford us sincere pleasure if we could dismiss this volume with no other language than that of commendation; but a somewhat careful examination has convinced us that the execution of the work is not equal to its pretensions. We have marked a pretty long list of faults more or less serious, and some of these we propose briefly to mention. It may seem a superfluous act of fault-finding to criticise the literary merits of

a work devoted wholly to science, but we cannot avoid expressing our regrets that the literary character of this work should be such as seriously to impair the pleasure of a perusal. The style of composition is often harsh and even slovenly; many words are used in an improper sense: and it is frequently no easy matter to discover the author's meaning. We will illustrate these remarks by a few examples.

On page 89 Mr. Blodget speaks of "the Rocky Mountain plateau throwing out some exception*able* districts." We suppose he means exception*al* districts. On page 487 he speaks of "the *rating* of instruments," that is, thermometers. We have often heard of *rating chronometers* and *verifying thermometers*, but never before heard of rating thermometers. On page 92 he says "the great plains of the Columbia River form a *climatological basin*." It has puzzled us not a little to ascertain what is a climatological basin. We can only guess that it must be a *basin having a climate;* but this does not remove the difficulty, for we are no less perplexed to determine what is a *basin not having a climate*. On page 345 he says, "As a *pendant* to the general notices of the quantity of water falling in the winter months, some distinctions should be made," etc. Here again we were forced to consult Webster and found eight significations of the word "pendant;" but after a strenuous effort to determine in what sense Mr. Blodget designed the word to be understood, we abandoned the attempt as fruitless. On page 348, he says, "the contact of *atmospheric volumes* with those altitudes induces precipitation," etc. We are not sure that we fully understand the force of the words we have here italicised, and we cannot avoid thinking that the phraseology is susceptible of improvement. Mr. Blodget makes very frequent use of the word 'symmetrical' as applied to the distribution of rain and heat. Often the word occurs several times on a single page, and frequently in such a connection as fails to convey to our mind any definite idea. In some instances we fancied the word was used in the sense of *uniform*, but we have searched our dictionaries in vain for any authority for such a use. As examples of the kind alluded to, we will refer to pages 346 and 347. Mr. Blodget frequently uses the word 'tone,' in a very peculiar manner. Thus on page 481 he says, "The demonstration of the constancy of the sun's heat cannot be undertaken here, and though it has not yet been made in any direct manner, the possibility of such demonstration will be admitted by all who would follow *that tone of proof*." If we could form any distinct idea of what 'that tone of proof' means, we might assent to the possibility of the demonstration referred to, but the meaning of the phrase could not be more effectually concealed if it were written in Chinese.

We will pass over a variety of passages in which there is apparently some typographical error, as on page 308 where the word "Observatories' should evidently read 'Observations;' but there is a large number of passages of which we are unable to divine the meaning, and where if there is any typographical error, it is not obvious what the error is.

On page 20 we read of "a record of meteorological observations mainly for the interest its startling phenomena gave, is a sort of interest it will never fail to have, and in which though having a philosophical air, *there can be no progress as positive science.*" On page 162, we read that "the *localization* of all the features of the climate is, from this point of comparison, the leading point of difference after that of the contrast in humidity." On page 355 we are told that "in a fluid mass which is aeriform the agitations are extreme in comparison with *its other conditions.*" On page 375 we are told that "the difference between the *distances* originating in the tropics as hurricanes, and the general rains 'originating inland, is merely one of degree." On page 519 we are told that "the winter and summer would mark these extremes of accumulation of heat first, and refrigeration next, were not each retarded by the operation of *laws inherent to the fluid or condition we designate as heat.*" We would respectfully suggest to the author that in case a second edition of the climatology should be called for, it would be desirable to add a few notes explanatory of the above passages.

Besides the class of passages already cited in which the meaning of the author is obscure, there is another class in which the meaning is apparently obvious, but which bear marks of having been written without due consideration. Thus on page 502 he says "the winter period is *always less* than that of summer;" but if we refer to the table on page 500 we shall see that out of 51 stations there mentioned, at 22 the winter is stated to be longer than the summer. On page 522, he says, "there must necessarily be much discrepancy in the *modes* of determining these points," viz: the days of maximum and minimum temperature. We suspect that the discrepancies referred to do not arise from differences in the *modes* of determination, but rather from the fact that some of the results are derived from short periods and others from longer periods of observation. On page 257 he speaks of "the isothermal lines as being more *definite* than a numerical quantity," that is, more definite than degrees of the thermometer. We have always been accustomed to consider the temperature of melting ice to be quite definite, and are surprised to hear that isothermal lines are *more* definite. On page 292 he says "there are *no sufficient data* for comparison with similar latitudes in Europe," referring to the first appearance of frost in autumn. We presume Mr. Blodget did not

intend to question the existence of such materials, but simply to state that they are inaccessible to him.

On page 156 he states that "the difference between the wet bulb thermometer and the temperature of the air sometimes reaches 30°." We have searched the book with considerable care in the hope of finding some particulars of these observations, but in vain. We do not intend to express any doubt of the accuracy of the above statement, but we think that a degree of dryness so remarkable is worthy of a more extended notice. On page 396 he says that "at Goldsborough, N. C., *snow fell for an hour or more* on the evening of Sunday, Aug. 31st, 1856." Among the many remarkable facts stated in the Climatology, this is one of the most remarkable, and we think Mr. Blodget should have been more careful to give his authority for the statement. On page 482 he says, "It is *certain* that no changes of subsidence, elevation, or continental outlines are now in progress." We cannot help regarding this conclusion as the most important addition which has been made in modern times to the science of geology. Perhaps some would question it.

On page 481, he says, "Laplace has shown that the mean temperature of the mass of the earth cannot have changed in any appreciable measure *within the entire period embraced by astronomical calculation, and that none can occur*, while the planetary movements remain what they now are." And on page 484 he adds, "Laplace has shown that the heat of the earth cannot have changed *for the vast period over which astronomical calculation can reach*." In order to comprehend the full force of this statement we must know how vast are the periods over which astronomical calculation *can* reach. The period of time to which astronomical calculations can reach is not limited to ten thousand years, nor a hundred thousand or a million of years; we can assign it *no* limit. If we enquire for the periods over which astronomical calculations *have* actually extended, we shall find them sufficiently long. Leverrier has computed that the eccentricity of the earth's orbit will continue to diminish during the period of 23,980 years. See Connaissance des Temps, 1843. Laplace found that the eccentricity of Jupiter's orbit has a variation whose period is 35,000 years. Lagrange found that the secular inequalities in the mean motions of Jupiter and Saturn extended to the period of 70,414 years. The secular inequality in the moon's mean motion has a *much longer period* than this. See Grant's History of Physical Astronomy, page 63.

Now Laplace has shown that the mean heat of the earth cannot have changed sensibly in 2,000 years, and *that is all*. He *has not shown* that it may not have changed sensibly in 10,000 years, and geological phenomena unequivocally prove that the temperature *has changed sensibly* within a period which is *not long when*

compared with the entire duration of the earth. Mr. Blodget's statement is here most seriously in error.

On page 356, it is stated that Professor Dove has expressed his dissent from the generally received theory of the trade winds, which theory requires a belt of prevalent westerly winds in the middle latitudes of the temperate zones. This statement has excited our unqualified surprise. In a volume published by Professor Dove in 1837 entitled "Meteorologische Untersuchungen" he has given a very full account of the trade winds and of the prevalent westerly winds of the temperate zones, and endorses in unequivocal terms the common theory on that subject which was first distinctly stated by Hadley. In his preface to that volume page v, Prof. Dove says, "In the year 1780, Hadley established a theory of the trade winds founded upon the rotation of the earth and the unequal temperature of the different latitudes, *which even in the details of the phenomena has shown itself to be the true theory.*" (Welche sich selbst im Detail der Erscheinungen als *die richtige* bewährt hat.) Those who are familiar with the writings of Professor Dove do not need to be informed that the same general views of the trade winds are expressed in all his memoirs upon this subject since 1837. The passage which Mr. Blodget quotes from one of Dove's memoirs was never designed to convey the idea which Mr. Blodget has imputed to it. Professor Dove merely insists that there may be local exceptions to the general law of prevalent westerly winds in the temperate latitudes, as there are local exceptions to the general law of the trade winds in the torrid zone. We assure Mr. Blodget that he has misrepresented the views of Professor Dove quite as seriously as he has the labors of Laplace.

We come now to notice a class of faults which affect more seriously the scientific character of the work. Mr. Blodget has treated somewhat briefly of tornadoes; of the winds; of the cause of rain, and of seasons of unusual cold; as well as of the laws of our winter storms.

On page 400, he mentions several cases of heavy weights being lifted up by the force of hurricanes in the West Indies. In one instance "a piece of lead 4000 pounds in weight was lifted and carried 1800 feet," and he adds, "other agencies than simply the force of wind must account for these extraordinary cases of lifting weights, and *the convective electric discharge is an obvious and adequate solution of the facts.*" If Mr. Blodget had closed this sentence with the word *perhaps*, it would have seemed more appropriate than in some cases where so introduced. See pages 144, 308, etc. As he has not given the reason for his opinion we shall not enter into any argument on the subject, but content ourselves with recording our firm conviction that electricity in any form *does not afford an adequate solution of the facts.*

On page 402, he says that "tornadoes are often evolute, throwing trees *outwardly* from the centre, instead of inward." We will not deny that the centre of a tornado often vibrates to and fro across the line of progress, giving sometimes the appearance of trees thrown outward from the centre; but that the force of a tornado is ever *really* exerted in a direction *from the centre*, we do not believe, and we challenge Mr. Blodget to the proof. On page 403 he says, "the permanence of a forest trace of a tornado could be relied upon *for at least five hundred years.*" Mr. Blodget may have evidence on this subject of which we are ignorant, but we confess we are very skeptical.

On page 355 Mr. Blodget expresses great contempt for the winds, and says "they deserve much less attention than has heretofore been given them in observation, and in general deductions they might even be omitted entirely." We think his indifferent success in studying the laws of storms, to which we shall presently refer, may be ascribed in some degree to his low estimate of the agency of winds. We find it difficult to reconcile the views which he has expressed on the subject of winds on different pages of his book. On page 382 he says "None of the winds [of the United States] from other than westerly points are winds of *propulsion*, or propagated from their apparent point of origin—they are all, including a portion from the west, winds of *aspiration.*" Now as throughout nearly the whole of the United States, the prevalent winds are from the west, we should infer from the preceding statement that Mr. Blodget intended to pronounce at least one half of all our winds to be winds of propulsion. But on page 372 he says, "there is *little evidence of the existence of any winds of propulsion;*" and on page 361 he says "*no such winds* [as winds of propulsion] *are now recognized anywhere* indeed." It would be interesting to know how these different statements are to be reconciled.

Mr. Blodget's views of the origin of rain are quite original. These views are not given in a very complete and systematic form, yet some general idea of them may be derived from the following extracts. On page 358 he says, "the higher strata of clouds come uniformly from some westerly point. The lower clouds are from various points, two strata of different movement often lying beneath that from the west, yet *the stratum from a westerly point usually deposits the rain.*" On page 359 he says, "the rains of the eastern United States fall mainly from the upper or westerly cloud, in all cases." On page 360, he says, "the water must necessarily fall from the upper cloud. It is impossible that such a storm should receive its principal supply of water from any other source than the mass of air moving from the west. The prevalent westerly winds must therefore be largely charged with vapor, and must exhibit a nearly constant

precipitation either as clouds or rain." On page 367 he says "the high rain-bearing clouds are borne on a westerly current for all seasons." It seems clear from these extracts that Mr. Blodget means to convey the idea that the moisture which is precipitated in the form of rain comes almost exclusively from that high stratum of air which throughout New York and New England moves almost invariably from the west. The cause of this precipitation is hinted at on pages 391 and 2, where he says "this class of storms [winter storms] originate in changes of the measures of heat and moisture introduced from *exterior sources.* The presence of a rarefied and humid mass, from which *rain will fall profusely by the natural loss of temperature* which must ensue after a brief presence in the temperate latitudes, will induce condensation first, winds from adjacent areas next."

Let us give this theory of rain a moment's attention. This upper stratum of air whose westerly direction is not interrupted by the easterly winds which prevail at the earth's surface during a violent winter storm, is the upper half of the atmosphere, and its lower limit may be estimated at not less than three miles in elevation. The mean temperature of the surface of the earth in the month of January on the parallel of 40° is about 32°. The decrease of temperature as we ascend is about one degree of Fahrenheit for 300 feet; or 53 degrees for an elevation of three miles, making the mean temperature of January in lat. 40° at the height of three miles −21°. In order however that we may not be suspected of exaggeration, we will assume the temperature to be that of zero. Now at zero of Fahrenheit, the elastic force of vapor of water is equal to $\frac{6}{100}$ inch of mercury, or less than one inch of water; that is, if air at the temperature of zero were saturated with vapor, and *every particle of the vapor were precipitated*, it would cover the earth with less than one inch of water. Now it not unfrequently happens in one of our winter storms, that over a circle of 500 miles in diameter, the average fall of rain exceeds one inch. It is very evident then that the upper stratum does not furnish the rain which falls in our great storms, for the simple reason that more water falls than was ever contained in that stratum; and moreover it is highly probable that this upper stratum contains well nigh as much moisture at the conclusion of a great storm, as it did at the commencement.

Mr. Blodget's views of the cause of seasons of extraordinary cold are also peculiar, but his conclusions are not stated with very great clearness. On page 307 he says, "the origin of these non-periodic oscillations is *exterior to the continent*, and they have no progressive movement. In no case is it apparent that these cold extremes come from the north, or are caused by north winds, or an inflection of the polar atmosphere southward." Mr. Blodget is confident that the origin of seasons of unusual cold

(as for example the winter of 1856,) is exterior to the continent —that is, it *does not come* from the continent; but we cannot find that he has any where intimated from what point it *does come.* As Mr. Blodget appears to entertain some respect for Professor Dove, we will extract a single sentence from Dove's 'Essay on the Distribution of Heat over the surface of the Globe,' page 18. "The different degree of severity in the winters of different years, depends *so evidently* in our latitudes on the prevailing direction of the wind in each case, that *there can be no doubt* as to the more immediate or proximate cause of this diversity."

Mr. Blodget regards the subject of winter storms as worthy of very little attention. On page vii. he says, "the surface dynamics are of very little importance." On page 394 he assigns a reason which if substantiated would entirely warrant the above conclusion. He says, "Forcible as the evidences of dynamic agency appear in this class of storms it is believed that *they are not subject to such laws.*" And again on page 391, "This class of storms originate in changes of the measures of heat and moisture introduced from *exterior sources*, and these changes are absolutely non-periodic and *cannot be foretold.* The ceaseless oscillations in the measure of heat and of aqueous vapor in the air of temperate latitudes from exterior causes, must render the computation of the elements of a perturbation so induced, *utterly beyond calculation;* since the primary and indispensable elements of the change are *beyond the possibility of being known.*" This is a gloomy picture of the prospects of meteorology.

He however mentions some conclusions which we regard as of great importance with reference to the phenomena of storms. On page 195 he says, "On the Pacific coast, rain always begins earlier at the northernmost stations than at the next southward; and on page 381, he says, "the general winter storms of the United States come from a point north of west at the Mississippi river." If Mr. Blodget means by these statements that in our ordinary winter storms on the Pacific coast and near the Mississippi river on the parallel of 40 degrees, the point of greatest barometric depression travels from northwest to southeast, we confess that this is something new to us, and invite him to name a case and produce his testimony.

On page 387 Mr. Blodget states that about the 1st of January, 1855, storms were experienced well nigh simultaneously on the Pacific coast, throughout the Mississippi Valley, along the Atlantic coast, in England, on the Baltic Sea, and even to the East Indies and the Sandwich Islands; and seems to intimate though in a somewhat guarded manner, that all these constituted in effect but one great storm. If Mr. Blodget can identify a single storm, tracing its progress clearly from day to day over half the distance here named, he will accomplish what no one has hitherto succeeded in doing.

On page 182 Mr. Blodget says, "The great winter storms are special proofs of the uniformity of the field over which the mass of our atmosphere, and the elements of heat, moisture, and *perhaps magnetism* which move it, pass through their succession of changes." If Mr. Blodget can show any necessary connexion between our winter storms and the phenomena of terrestrial magnetism, he will make a positive addition to the science of Meteorology, and will have done something to show that storms are subject to *laws*.

On page 380 he says, "In the colder months the change of condition, both as regards temperature and the quantity of aqueous vapor suspended, affects the whole mass in greater degree than when the rain is deposited in showers. For this reason the range of the barometer is greater, and this range is a very direct measure of the relative condition, so that *the readings may be taken as simple representatives of the quantity of heat and moisture present compared with the average*." Mr. Blodget here seems to advance the doctrine that the oscillations of the barometer which are so common in winter are adequately explained by the changes in the temperature of the air and in the amount of aqueous vapor. If this is Mr. Blodget's view, we differ from him totally. Changes in the temperature of the air and in the amount of aqueous vapor, would doubtless cause changes in the height of the barometer; but these causes are *inadequate* to explain the actually observed oscillations of the barometer. In some parts of England the observed range of the barometer is 3½ inches, indicating a variation of pressure to the amount of over *one ninth* part of the whole quantity. During tropical hurricanes the barometer has been observed to fall *about two inches in three or four hours*. It is easy to show by numerical computation that no admissible supposition respecting variations of temperature or moisture will account for such extreme oscillations of the barometer. Moreover it is not uncommon in Europe for a fall of the barometer to be accompanied by a fall of the thermometer; so that the barometer may even fall in spite of *an increased specific gravity of the air*.

In conclusion, we will sum up our judgment of the Climatology in a single sentence. The field which Mr. Blodget has occupied is a new one, and portions of it have hitherto been wholly unexplored—Mr. Blodget has enjoyed unusual advantages for this research from his connection with the Smithsonian Institution, and the Surgeon General's office at Washington; and we regard his isothermal and rain charts as constituting an important addition to the science of Meteorology: but his book is loose in style and often obscure; it contains many careless and sometimes erroneous statements: and the views which it embodies respecting the causes of the most common meteorological phenomena are radically erroneous. X.

ART. XXIV.—*Preliminary notice of a new base containing Osmium and the elements of Ammonia;* by WOLCOTT GIBBS and F. A. GENTH.

AN investigation of the ammonia-cobalt bases, the results of which have appeared in this Journal, has led us to direct our attention to the production of similar compounds with other metals. We have in particular studied the action of the mixed oxyds of nitrogen, NO_2, NO_3, and NO_4, upon ammoniacal solutions, and have obtained results which will form the subject of a future communication. In the course of an extended study of the platinum metals, for which we have enjoyed peculiar facilities, we have remarked that osmium forms with ammonia a well characterized base, all the salts of which appear to be highly crystalline.

The chlorid of this base is a yellow crystalline salt first obtained by Fremy in 1844, and described in his memoir* on the metallic acids, under the name of osmiamid. To this body Fremy attributes the formula $NH_4Cl+OsO_2.NH_2$, according to which it is to be viewed as a compound of chlorid of ammonium with an amid of osmious acid.

We have however found that the substance in question is a true chlorid which yields a beautiful salt with bichlorid of platinum, and which by double decomposition with salts of silver enables us to form a well defined sulphate, nitrate, oxalate, &c. The best method of forming these salts however is precisely that which Fremy employed for the chlorid, and consists in adding a solution of osmite of potash to a cold solution of an ammoniacal salt, when the new salt, is immediately formed and crystallizes from the solution.

The salts of the new base have a very beautiful orange yellow color. They are nearly insoluble in cold water; hot water dissolves them more readily, but the solutions are easily decomposed with evolution of osmic acid. We are not as yet prepared to pronounce with certainty upon the constitution of these salts, the analyses being difficult and tedious. We may however remark that Fremy's analysis of the chlorid appears to be correct, and that we attribute to it the rational formula

$$2NH_3.OsO_2, Cl,$$

according to which the base will be uniacid. The results of our complete investigation will form the subject of another communication. Iridium and Rhodium form with ammonia and deutoxyd of nitrogen bases analogous to Xanthocobalt, with the study of which we are also occupied.

* Annales de Chimie et de Physique, 3d series, vol. xii, p. 521.

ART. XXV.—*Review of the Operations and Results of the United States Coast Survey.*

[Concluded from p. 83.]

THE publication of maps and charts constitutes, as may be supposed, one of the main objects of the survey. Upon the preparation of these an immense amount of labor is bestowed, the value of the work consisting chiefly in the accuracy of the details. In fact the whole subject may be fairly considered as constituting a special branch of science, with a system of signs and a mode of expression peculiar to itself. The most advantageous methods of presenting to the eye an easily intelligible view of the topography and hydrography of the coast have of course occupied a very large share of attention. The general treatment of the subject, the arbitrary signs and other details being once settled, and the triangulation and plane-table work being finished, the maps are drawn and the work of the engraver begins. In order to render the results of the survey useful and accessible as soon as possible, and at the same time to exhibit the progress of the work, three classes of charts are engraved. These are termed sketches, preliminary charts, and finished charts. The sketches are of two kinds; progress sketches showing from year to year the advance of the work, and sketches of parts of the coast whether connected or detached. These are generally engraved by apprentices in the office of the survey and serve as subjects for practice. They are added to, year by year, and lithographic transfers published in the annual reports. In this manner it rarely happens that a year elapses between a survey and its publication in some useful shape. The preliminary charts serve nearly the same purpose as the sketches, but are larger and more finished.

The finished charts are divided into three classes. The first are called inshore or coast charts, and are drawn to a scale of $\frac{1}{80,000}$. They embrace the shore line, the interior as far as the nearest main road, and the hydrography for about fourteen miles from the shore. The second class embraces what are termed off-shore or general coast charts, drawn to a scale of $\frac{1}{400,000}$, giving the shore line and the general topography of the coast, so that it may be recognized by the navigator, but omitting minute details and giving the soundings to the depth of at least 120 fathoms. The third class is composed of minutely detailed charts of harbors, anchorage, &c., exhibiting the sounding, tides and currents, the outline of the shore, the topography of the adjacent country, in short, presenting the complete results of the survey. These charts are drawn on scales varying from $\frac{1}{5000}$ to $\frac{1}{80,000}$.

The finished charts require the work of first class engravers. These are so difficult to procure that in spite of the urgent necessity of the case and the unceasing efforts of the superintendent, there were but four first class engravers in the office at the beginning of the year 1856. Even these were only obtained by a special agent sent to Europe for the express purpose. With a wise liberality the charts are sold at the lowest possible rates, while the gratuitous distribution of the annual reports of the Coast Survey gives a still wider circulation to its graphical results.

As the greater number of maps and charts are engraved upon copper, and as the softness of this metal renders it impossible to obtain more than a limited number of impressions from a single plate, a method of reproducing the plates themselves becomes indispensable. Such a method is found in the electrotype process, which is now applied in the office of the survey upon a very large scale, and which has there received a development and a perfection which leaves little to be desired. We believe that we hazard little in asserting that as regards the thickness and quality of the metal precipitated, the size of the plates, the prevention of adhesion between the original plate and that deposited, and the absolute command of the whole process, the electrotype operations of the Coast Survey are unequalled in any country.

It has very recently been found possible to print from thin electrotypes merely folded over the edges of a stout plate of metal which serves as a support or back. In this manner plates of the first quality can be furnished for about one-third of the cost of those deposited of the usual thickness. Processes are also employed by which small plates can be pieced out in any direction and to any desirable size, no line of junction being visible between the original and the addition.

The particular apparatus and arrangements employed in the electrotype department have nearly all originated in the department itself, and have been fully described in the annual reports of the survey and in this Journal. It cannot be doubted that they have exerted a positive influence upon the progress of this branch of art.

It was just that an elaborate and complete survey of the phenomena of the Gulf Stream should be executed by a descendant of Franklin, and it may well be conceived that the peculiarities of that magnificent current, alike interesting from the practical and the scientific point of view, have engaged a special share of attention. In accordance with the direction of Congress that a map exhibiting the state of our knowledge of the Gulf Stream should accompany the report of 1853, the work of investigation was pushed forward during that year and results of great inter-

est obtained, and illustrated in two charts appended to the report. These results show that the Gulf Stream is not, as generally supposed, a single broad current of warm water flowing in a northeasterly direction, but that it is in reality an aggregate of separate currents alternately cold and warm, and exhibiting a certain degree of parallelism. The method of examination employed was the very obvious and natural one of running numerous sections across the Stream and observing the depth of the water and the temperature at different depths. The number of positions observed in each section was made to depend upon the more or less rapid changes of temperature, and the temperatures were observed at the surface and at depths of five, ten, twenty, thirty, fifty, seventy, one hundred, one hundred and fifty, two hundred, three, four, five and six hundred fathoms, so as to reach into the cold polar currents lying beneath. In this manner ten sections were surveyed, the temperatures being determined for moderate depths with Six's self-registering thermometers, and for greater depths with Saxton's metallic thermometers. If we employ the term Gulf Stream in its broadest sense and understand by it the aggregate of *all* the warm currents flowing from the Gulf of Mexico into the north Atlantic, a glance at the Coast Survey map shows us at once the existence of at least four distinct warm currents separated from each other by cold bands, a fourth cold band separating the first or inner warm band from the shore. Each warm band is narrowest and warmest in its most southerly section—that of Cape Canaveral—and becomes broader and cooler in its progress northward and eastward, while its boundaries become less and less clearly defined. The most cursory observation shows that these bands are parallel to the outline of the coast, and that as we recede from the shore upon any section they become broader, cooler, and less sharply separated from the intervening cold masses. The Gulf Stream proper forms the second warm current in order from the shore. As might naturally be expected from its greater density the colder water tends to occupy the lowest position, but instead of forming a level plateau it follows the irregularities of the bottom. This again determines the vertical distribution of the warm currents, and we find accordingly that in each section, as far as examined, the curves which represent the depths corresponding to equal temperatures are sensibly parallel to the contour of the bottom. This fact is well illustrated on the Charleston section, where the bottom of the ocean exhibits remarkable irregularities. Thus the depth on this section gradually increases to a distance of fifty-three miles, when it suddenly descends to upward of six hundred fathoms. Ninety-six miles from the coast we find a range of hills, having a height of eighteen hundred feet and a base of about eleven miles on the seaward side.

One hundred and thirty-six miles from the coast occurs another range of hills fifteen hundred feet high and twenty-eight miles base toward the shore, and six hundred feet high with a base of about seventeen miles on the outer side. Beyond this there is a more gradual rise. Now the forms of the curves of equal temperature resulting from multiplied observations at different depths along the section correspond exactly to the outline of the bottom.

Perhaps the most remarkable peculiarity of the Gulf Stream is what has been appropriately termed the "cold wall," a mass of cold water lying between the warm water and the shore, and sharply defining the inner boundary of the great current. The change from the warm water of the stream to the cold body of water inside of it toward the shore, is particularly sudden and well marked in the northern sections, but may also be easily distinguished south of Cape Hatteras. In the cold water inshore from the Gulf Stream a current setting southward has been observed, as also in the cold band outside the axes. It is not yet certain however that these are permanent currents.

Another remarkable fact is observed in comparing the temperatures of the northern and southern portions of the Gulf Stream. Taking the maximum temperatures at twelve or fifteen fathoms beneath the surface, there is, as a general rule, an increase of temperature in passing southward. But in successive years we find the highest temperature at twelve fathoms, on the Cape Henry section, higher than at Hatteras, while the temperature in the axis of the stream at Sandy Hook in July, 1846, was higher by five and one half degrees than at Charleston in June, 1853. The underlying polar currents are as distinctly marked in the southern as in the northern latitudes. Thus in latitude 37° 20′ the temperature at a depth of four hundred fathoms below the warmest water of the Gulf Stream in August, 1846, was 49° Fahr., while in the same position in latitude 28° 20′ it was $48\frac{1}{2}$° Fahr. The fact that the side limits of the polar current recede from the shore as the depth increases is clearly marked on all the sections.

It is hardly necessary to observe that much remains to be done to complete the survey of the Gulf Stream. But it may be justly asserted that the results obtained by the Coast Survey have placed the whole subject in an entirely new point of view and have contributed greatly to the solution of one of the grandest problems in physical geography. It may be remarked in this place that the most recent observations fully confirm the theory of Franklin that the Gulf Stream makes a complete circuit in the Atlantic, returning again to its source. A branch of the main current is however thrown out toward the coasts of Ireland and Norway, and is thence reflected toward the Arctic ocean. This branch appears to offer the most feasible passage

to the open polar sea, to the discovery of which so much attention has been recently directed, and which appears to be in fact only a forgotten reality.

We have adverted to the observations of latitude, azimuth and longitude as requisite to determine the position on the earth's surface of the stations, the relative situation of which as to distance and direction is ascertained by triangulation. They serve thus incidentally to determine the *figure* of that portion of the earth over which the work extends. While in other countries extensive operations have been executed for the special purpose of measuring arcs of meridians and parallels, the Coast Survey furnishes those important additions to one of the highest departments of physical knowledge, without any expenditure not absolutely necessary for the perfect attainment of its most direct and practical objects. An individual arc of 3½ degrees from Nantucket to Mt. Blue in Maine—another of 2½ degrees from the head to the capes of Chesapeake Bay, which may be extended 1½ degrees farther to Cape Hatteras, and an arc of the parallel extending 4° from Nantucket to New York are among the results already obtained. They exhibit a general conformity to the elements of the earth's figure deduced from all previous measurements, while they show marked local variations which have become the subject of special study.

These variations in the direction of the plumb-line are found to be not only such as would result from want of uniformity in the geological structure in the immediate vicinity of stations, but to extend like undulations over considerable regions.

In order to obtain these "station errors" as free from residual instrumental errors as possible, the capabilities of various instruments and methods for determining latitude have been successively tried, large vertical circles, repeating circles, the prime vertical transit, the zenith telescope (or equal altitude instrument), and Airy's zenith sector. The latter instrument is the most perfect of its kind, possessing many improvements on the zenith sector of the British Ordnance Survey, the only other of the kind in existence. * The accuracy of its results, however, is rivalled by those of the zenith telescope, the application of which to observations of latitude by equal meridian altitudes of stars to the north and south of the zenith is of American origin and has been greatly perfected in the Coast Survey. Combining portability and facility of use, with great accuracy, it has become the favorite instrument, and no observer, who has ever used it, is willing to return to others.

In order to bring out the various elements of error, observations have been made at the same stations with different kinds of instruments, with the same instrument by different observers, and by the same observer with two different instruments of the

same class. By a consistent application of the method of least squares, the observations have been severely scrutinized, and their relative values determined without the admission of anything like arbitrary preference.

Looking at the observations of azimuth we again find the Coast Survey testing the relative value of known methods and perfecting them or devising new ones, not only *proving* but *improving* all. Abandoning the methods by observations of the sun at low latitudes and by transits of stars over the verticals of stations, as involving too largely the difficult element of *time*, the observations of azimuth have been made principally on close circumpolar stars, especially the pole-star. The reduction of observations made near the time of the star's greatest eastern or western elongation, has been greatly facilitated by the use of a simple formula. An elegant method has been introduced, of observing the star at corresponding equal times before and after either culmination, by which arrangement the labor of computation is almost entirely saved, the mean of each pair of corresponding observations giving at once the meridian. The observations of azimuth have shown irregularities to exist in the direction of the plumb-line similar in kind and amount to those indicated by the latitude observations.

One of the most important and striking features of the methods of the Coast Survey is the total absence of eclecticism, which in former times was an acknowledged principle with observers, and to which there is even now a strong leaning in some quarters. The observer may indeed choose circumstances favorable to his purpose and may affix to the observations a statement of facts affecting their quality, but here the influence of his judgment or bias ceases. The observations are made to tell their own story, and by the searching test of the method of least squares their relative weight is ascertained, and rejections, if necessary, are made according to Peirce's criterion. The step is taken or combination made; but the reasons for it are such as to be necessarily arrived at by every one, according to the principles laid down. All observations are liable to more or less uncertainty, and there are probably classes of errors which no number of observations or variety of methods can entirely eliminate; it will always be necessary to discriminate, and to apply small corrections to the results in order to make them fulfil the theoretical relations existing between them. When this is done according to fixed mathematical rules all uncertainty vanishes, and truth must be the gainer, while on the other hand when it is allowed to be done according to personal judgment or bias, results must vary with different computers, and the door is opened to falsification and fraud.

The Coast Survey is at present under the general control of the Treasury Department, which appoints its officers and regulates their compensation. The Department furthermore authorizes all expenditures, approves the plans and estimates of the superintendent, and makes general regulations for the work under the law. The immediate agent of the Treasury Department is the superintendent, who arranges the plan of conducting the work, attends to its business details, issues instructions for its execution, and is responsible for the scientific accuracy of the whole. All persons and parties employed report directly to the Superintendent, who in turn presents an annual report to the Department, offering a complete and detailed account of the work done during each year. The annual reports are amply illustrated by maps and charts, and are extensively and gratuitously distributed. The distribution is made by the assistant in charge of the office who has all the reports in his possession and who distributes them according to a prepared list.

In addition to the laborious duties of the general direction of the survey, and inspection of the parties, the Superintendent himself personally assists in the execution of the work, taking the field and making observations as required. The different parts of the work are entrusted to assistants who act as directed by the Superintendent and are responsible to him, the office of the survey being considered as a party with an assistant in charge. Each field party consists of a chief, who may have one or more assistants, and of several hands. In the office, computers, draughtsmen, engravers, printers, mechanics, clerks, &c., are employed as occasion may require.

In the organization of the survey three classes of persons are recognized by law. These are civilians, officers of the army, and officers of the navy. The civilians form the permanent nucleus of the survey. Their salaries are under the control of the Department, and they are promoted or lowered according to their merit as measured by the results of their work. As they are not, save only in exceptional cases, subject to frequent changes, they form a constantly efficient and trained body and preserve uniformity in the business and methods of the survey. Such a nucleus is obviously indispensable as the whole work might otherwise be disorganized by calls for the professional services of officers of the army and navy. Thus on the breaking out of the Mexican war all the officers of the line of the army and part of those of the staff, serving on the Coast Survey, were detached for active military service.

The officers of the army and navy are detailed by the heads of their respective departments on the application of the superintendent through the Treasury Department. They receive no extra emolument from the Coast Survey and are of course liable

to be frequently changed. Their employment is, however, very advantageous both to the Survey and to themselves, since they furnish to the former active, intelligent, and zealous assistants, while they of course profit by the peculiar scientific training offered in the service to which they are detailed.

In fact it is easy to see that there is no part of the hydrography or of the topographical surveys which does not furnish advantageous practice to an officer in either branch of the service. The topographical engineer finds employment in his own department. The survey of harbors and the study of tides, currents, shoals, entrance channels, and all those peculiarities which distinguish the different seaports, are of the utmost importance in determining the proper sites for fortifications and permanent defenses. They furnish weapons of offense as well as defense. In the recent European war the success of several important operations depended wholly upon the skill and promptness with which surveys were executed by naval officers. But even in time of peace the advantages of having on board of every ship thoroughly trained hydrographers can hardly be overestimated, for commerce, and therefore civilization, profits by every new harbor surveyed, every channel sounded, every current whose course and velocity are traced. The law requires that as many officers of the army and navy be employed as may be compatible with the successful prosecution of the work.

The work of the Coast Survey is naturally divided into field and office work. The field work consists in the actual surveys and observations of various kinds and is either original or of verification. The methods of conducting the work are laid down in general instructions by the superintendent who also directs what scientific processes and instruments are to be employed. The assistants make monthly reports in prepared forms and keep daily journals which are placed on file in the office. A general report is also made to the superintendent on taking and leaving the field, and in the month of October of each year for the annual report.

The office work consists of computing, drawing, engraving, printing, &c., and is for the most part under the care of the assistant having charge of the office. The publication and distribution of maps and the care of the accounts and property are placed in the charge of the general disbursing agent who gives bond to the Treasury Department.

The minute attention required to secure accuracy in the computations of the Coast Survey is well exhibited in the system of checks employed. The field parties in the first place compute their own work and a second computation is then made independently by persons having no connection with the field work. The assistant in charge of the office then examines and com-

pares the two computations and reports any discrepancies to the superintendent for examination. The records of observations and calculations are put in form for publication by the assistant in charge of the office under the direction of the superintendent, but the records and results now publishing as a separate work are under the charge of a special officer. Drawings are first executed by the field parties and reductions of these to the scale of publication are then made by regular draughtsmen in the office, and these drawings are finally revised and verified. It is almost needless to mention that all the topographical signs, forms and sizes of letters, &c. are prescribed by rule so as to be uniform. This subject, as already mentioned, is one which required special study. Thus the scale of shade is made to express the degree of slope by the strength of the hachure lines and the distance between them. The engraving of the maps and charts is under the charge of an assistant who verifies all engraved maps; from him they pass to the assistant in charge of the office who finally reports them to the superintendent.

The prices of the maps and charts are fixed by the Treasury Department upon the general principle that the sale should pay for the cost of paper and printing. The small maps are sold for fifteen and the larger for twenty to fifty cents. Besides the distribution by sale many copies are forwarded to literary, scientific, and commercial institutions, as designated by the Treasury Department.

In all cases the original records of observations and field work are transmitted to the office after duplicates have been made by the field parties. These are deposited in a fire-proof building in charge of the general disbursing agent. The instruments belonging to the Survey, properly marked and numbered, are also deposited in a fire-proof building, the repairs being almost always executed in the office.

The general estimates for the Survey are made by the superintendent who controls the expenditures for field and office work. On receiving his instructions for work, which usually state the limit of expenditure, the assistant makes an estimate for the number of hands required and for the general expenses of his party. This estimate, after the approval of the superintendent, is the authority of the disbursing agent in settling the accounts. The rules of the work require that a voucher in the form of a receipt be presented for all sums exceeding one dollar.

The chief of each party keeps an account of the party disbursements and transmits it to the general disbursing agent who supplies funds, audits accounts, and is responsible to the Treasury Department.

Beside the very numerous duties of supervision and of personal exertion which are discharged by the superintendent, there

are many special subjects which are under his immediate direction and in charge of a special assistant. Such are the researches upon the tides and the Gulf Stream; the preparation of the records and results for publication; the longitude work both astronomical and telegraphic; experimental researches on various practical subjects bearing directly upon the survey; the expansion of paper and the various modes of making and preparing it; the covering of copper plates with surfaces of iridium; improvements in different kinds of engraving, and other matters too numerous too mention.

The amount of labor, skill, and care required to maintain the harmonious action of the different parts of an organization like that of the Coast Survey may easily be imagined, and we may not unreasonably ask how many scientific men in our own, or in any other country, possess the extent and variety of knowledge combined with the tact and the executive capacity which such a work demands, and which it has called forth.

The Coast Survey is a national work of which we may well be proud. No other geodetic operations have ever been conducted upon so gigantic a scale, or have yielded such fruits of usefulness and honor. The work is worthy of the national spirit which originated it and which it illustrates. It is one of the great ideas which we have carried out. Like every great work it has a permanent value, and if national in conception and in execution, is universal in its example and its utility. It is estimated that if the annual appropriations are continued upon the present scale, the survey can be completed in about twelve years. May we not hope that it will continue to command the sympathy and support of every patriot, and that it will be permitted gloriously to complete that which has been so worthily begun.

ART. XXVI.—*Description of New Carboniferous Fossils from the Appalachian, Illinois and Michigan Coal-fields;* by R. P. STEVENS.

BELLEROPHON.—*B. globosa*, n. s. Shell globose, symmetrical. Ears extended and partially enrolled around a small umbilicus. Outer lip moderately inflated. Sinus wide. Pillar lip smooth, scarcely projecting into the mouth of the shell. Surface, exhibiting ridges, extending from one umbilicus to the other, slightly curved backwards on the dorsum. No carina. Width 0·7 of an inch, height 0·6 of an inch.

Geological position. In the upper shales of the coal measures, associated with B. urii, B. percarinatus, Myalina subquadrata, Pleurotomaria virgillati, and other carboniferous fossils.

Locality: Lasalle, Ill.

[redacted]

ACLIS (Loven).—1. *A. minuta*, n. s. Shell turreted, elongated, slender. Whorls 10, rounded, gradually diminishing to the apex and ornamented (on the body whorl) with 12 very minute longitudinal lines, which are stronger on the lower half of each whorl. Apex polished. Length 0·2 of an inch, width (body whorl) 0·05 of an inch.

Position and locality: roof of the Danville, Ill. coal seam, which is the third in the ascending series.

2. *A. robusta*, n. s. Shell turreted, tapering. Whorls 7, body whorl more robust than the others, one-third as wide as the total length of the shell. Ornamented with longitudinal lines, which are obsolete on the upper side of the apicial whorls. Pillar lip curving outwards to meet the labrum, which is thin and regular and united to the body whorl at right angles.

Dimensions: length 0·3 of an inch, width of body whorl nearly 0 15 of an inch.

Position and locality as the preceding.

CHEMNITZIA (D'Orbigny).—*C. attenuata*, n. s. Shell turreted, elongated, slender. Whorls 12, flattened, regularly diminishing until lost in a smooth, minute apex. Whorls exhibiting numerous scooped indentations, which are continued to the upper edge of each volution, giving at the suture a nodulated appearance.

Dimensions: length 0 3 of an inch: body whorl, width 0·1 of an inch.

Position and locality as the preceding.

LOXONEMA (Phillips).—1. *L. Newberryii*, n. s. Shell robust, elongated, spire tapering and acute. Whorls 8, slightly rounded and exhibiting, under the glass, minute oblique striæ. Body whorl, scarcely inflated, once and a half as long as the spire. Apex minute, polished. Columella with two distinct folds, with a corresponding groove between them and gently prolonged to meet the outer lip at an acute angle. Labrum thin, not effuse.

Dimensions: length 1·3 of an inch, width of body whorl 0·5 an inch.

Position and locality as the preceding.

2. *L. carinata*, n. s. Shell robust, elongated, spire more rapidly tapering than in the preceding species. Whorls 7, slightly rounded, and at their suture bearing a sharp carina extending from the upper angle of the mouth to the extremity of the spire. Mouth twice as long as wide. Columella with a distinct fold.

Dimensions: length 1 inch, width of body whorl 0·4 of an inch.

Position and locality as the preceding.

3. *L. Danvillensis*, n. s. Whorls 7, rapidly diminishing, gently rounded, ornamented with numerous oblique hair-like striæ. Body whorl inflated equal to the spire. Apex minute polished. Pillar lip with a slight fold. Labrum thin and effuse.

Dimensions: length 0·45 of an inch, width of body whorl 0·20 of an inch, width of mouth 0·10 of an inch.

Position and locality as above.

This shell is the shortest of the family which has come under my observation, and for some time it was classed under the Macrocheilus: but after examination of numerous specimens it is placed among the Loxonema.

4. *L. polita*, n. s. Shell slender, elongated. Whorls 6? oblique, slightly rounded, under the glass exhibiting numerous filliform striæ, which converge at the sutures. Apex? (wanting in the specimen). Labium with a slight fold and slightly reflected. Labrum thin and not effuse. Mouth one-half the width of the body whorl.

Dimensions: length 0·5? of an inch, width of body whorl 0·2 of an inch, width of mouth 0·2 of an inch.

Position and locality: roof of Danville coal.

5. *L. nodosa*, n. s. Shell robust, elongated. Whorls numerous, flattened, and exhibiting rudimentary nodes. Mouth and body whorl equal. Pillar lip smooth.

Dimensions: length 1·00? inch, width of body whorl 0·40 of an inch.

Position: in the unproductive shales between the upper and lower coal series of the Appalachian coal measures.

Locality: Summit, Columbiana Co., Ohio.

6. *L. tenui-carinata.* Shell slender, elongated. Whorls 6? very slightly rounded, a hair-like carina at the sutures. Apex? (wanting). Body whorl not inflated. Pillar lip smooth.

Dimensions: length 0·50? of an inch, width of body whorl ·02 of an inch.

Position and locality as above.

7. *L. minuta*, n. s. Shell small, slender. Whorls 6, smooth, gently rounded, body whorl more than one-half the total length of the shell, apex minute, suture well defined, columella smooth and gently curving outwards to meet the labrum. Mouth one-half the length of the body whorl.

Dimensions: length 0·2 of an inch; width of body whorl 0·05 of an inch.

Position and locality: in the roof of Danville coal and upper shales of Sangamon Co., Ill.

ACROCULIA (Phillips).—1. *A. trigonalis*, n. s. Shell galeated. Whorls scarcely two. Beak incurved, sinistrally inclined. Body whorl rapidly enlarging, inflated. Surface covered by rough imbricated lines of growth, which proceeding from the margin, curve first downwards and then upwards, crossing on the dorsum and giving there almost the appearance of a carina. Mouth subtrigonal.

Dimensions: height 0·7 of an inch, width of body whorl 0·5 of an inch.

Geological position: in a thin band of argillaceous limestone twenty feet below the Danville coal seam.

Locality: Danville, Ill.

2. *A. ovalis*, n. s. Shell galeated. Volutions two and one-half, contiguous, the last whorl greatly inflated. Spire delicate, depressed. Surface smooth, mouth oval.

Height 0·10 of an inch, width of body whorl ·15 of an inch.

In Archimedes beds of mountain limestone.

Union Co., Ill.

NATICA (Lamarck).—*N. Magister*, n. s. Shell very robust, ventricose, short. Whorls 3, the apicial small, body whorl rapidly increasing, inflated, extended below. The suture is well defined. The body whorl exhibits a strong prominent ridge, equal in width to one-fourth of the body whorl. Surface ornamented with coarse striæ which gently curve upon the dorsum, and mounting over the ridge converge at the suture. Pillar lip and umbilicus in the specimen covered with the matrix. Labrum thick. The surface is of cinnamon color and polished.

Height 1·00 inch, width of body whorl 1·20 of an inch.

Locality and position as the preceding. Near Macanda, Ill.

PECTEN (Muhler).—*P. carboniferus*, n. s. Shell sub-orbicular. Hinge-line straight, auricled. Anterior auricle equal to the anterior width of the shell. Posterior auricle wanting in the specimen, what portion is left is rugose. Right valve: beak acute, appressed to the hinge-line, polished. Disk rounded, surface marked by 15 acute ribs, which are ornamented with three series of sharp and more than semicircular scollops, of which the first and more robust series are at the ventral margin, the second is not far removed, the distance of the third and lightest series is from the second double that of the second from the first. Umbone and apex smooth and polished.

Length 0·45 of an inch, height 0·35 of an inch.

Geological position: in the upper shales of the coal measures, at Crooked Creek, Marion Co., Ill.

LEDA (Schumacker).—1. *L. bellistriata*, n. s. Shell twice as long as wide, equivalve, inflated at the umbones. Beaks anterior to the middle of the shell, sharp incurved, appressed, pointing towards the posterior extremity. Margins smooth. Hinge-line curved, armed with twenty-five teeth, about five of them are clustered under the beak, and weaker than their fellows. Escutcheon long, deep and narrow. Surface marked by numerous sharp longitudinal striæ, strong on the disk but fading before they reach the escutcheon and posterior extremity of the shell. Anterior extremity broadly rounded. Posterior produced, attenuated and acutely rounded.

Length 0·7 of an inch, height 0·4 of an inch.

Geological positions: in the roof of the Danville coal, and unproductive shales; Summit, Columbiana Co., Ohio.

2. *L. dens-mamillata*, n. s. Cast twice as long as wide. Beak nearly equal to the anterior of the shell, obtuse, does not touch the hinge-line, surrounded at its base with 7 distinct nodes with corresponding pits—impressions of the pedal muscles. Hinge ornamented with 25 mammillary teeth, slightly elevated and surrounded by a faint ring. Teeth under the beak are feeble, all are posterior. Anterior extremity slightly projecting beyond the beak and truncated. Posterior slightly produced, thin and rounded. Shell inflated at the umbones.

Length 0·9 of an inch, height 0·5 of an inch.

Locality: Battle Creek, Mich.

Geological position: in ochreous shales belonging to the coal measures of Michigan, as is supposed, although found farther west than these are generally thought to extend. It is associated with an Orthoceras, Nautilus and Bellerophon Urii, which is evidently carboniferous, and the following fossils.

3. *L. nuculæformis*, n. s. Shell inflated at the umbones, nearly twice as long as wide. Beak at the anterior third appressed to the hinge-line. Anterior and posterior extremities nearly equally rounded. Posterior slightly produced and attenuated. Hinge-line curved, with 25 teeth posterior and 5 anterior. Under the beak the teeth are feeble and more robust proceeding backwards, the last 10 are large, sharp, and set obliquely to the hinge margin.

Length 1·4 inch, height 0·6 of an inch.

Battle Creek, Mich.

4. *L. pandoræformis*, n. s. Shell (cast) flat but moderately inflated at the umbones. Beaks near the middle of the shell, wide at the umbones. Anterior extremity broadly rounded. Posterior much produced, attenuated and rostrated. In the cast a strong ridge is seen, descending from the beak and curving with the hinge-line, reaches the posterior extremity. Another strong ridge descends from the beak more abruptly to near the ventral margin and then proceeds parallel to the former ridge, until lost in the rostrated extremity, leaving a wide deep fossa between them. Shell exhibits on the surface strong longitudinal lines of growth, arranged in triple series. Cast resembles the Pandora, and hence the specific name. Teeth scarcely visible, probably 10 anterior, 20 posterior, long and slender.

Battle Creek, Michigan.

NUCULA (Lamarck).—*N. Houghtoni*, n. s. Shell equivalve, longer than wide. Beaks obtuse, not incurved. Anterior extremity truncate. Posterior acute. Surface smooth. The cast shows pedal muscular impressions at the base of the beak. Posterior adductor muscular impression strong, elevated, semicircu-

lar, situate at the posterior extremity of the hinge-line. Anterior adductor scar fainter and smaller. Hinge-line armed with 9 robust triangular teeth, hollowed at the base and strengthened by strong lateral ridges. Teeth pointing towards the beak, and rising in an arched form from the hinge-line: the inner 8 being 0·1 of an inch high, while the outer are only 0·5 of an inch.

Length 0·7 of an inch; height 0·4 of an inch.

Battle Creek, Mich.

CHONETES (Fischer).—*C. Michiganensis*, n. s. Shell small, inequivalve. Cardinal area formed at the equal expense of both valves. Receiving valve with the disk highly and regularly arched. Hinge-line straight, not equal to the width of the shell. Ears rounded, thin. Ventral margin regularly rounded. Surface ornamented with numerous delicate ridges, which are alternately more robust, arising at the beak, increasing in number as they cross the disk, and on reaching the ventral margin amounting to 80–90, and minutely punctate. Seven slender spines are seen on each side of the beak, on the hinge-line, of which the inner 3 are grouped together and point towards the beak, the outer 3–4 stand progressively farther apart and point more obliquely—the outer stands at right angles to the margin. The outer spine is only to be seen in mature specimens—spines more conspicuous on the casts. Interior of receiving valve is deeply hollowed. A strong septum extends from the beak to the ventral margin. The punctate striæ are more distinct than on the exterior surface. Two conspicuous lateral teeth on each side of the deltidium project inwards and downwards. One arises from the outer the other from the inner edge of the cardinal area.

The cast of this valve exhibits a deep fissure caused by the septum, with the impression of the punctate striæ strongly and regularly impressed upon the margin. Entering valve slightly concave. Hinge-line straight, not equal to the width of the shell. Beak slightly projecting, ornamented with numerous punctate striæ, similar to the opposite valve. Interior exhibits a shallow sinus, beginning at the beak and increasing in width as it approaches the ventral margin, well defined by a sharp ridge on either side, and bearing within it 8–10 filiform punctate striæ. Twenty rows of robust, short, tubular spines on either side, but do not reach the margin by the space of 0·05 of an inch, which space is marked by 80–90 fine, regular striæ. Impressions of tubes and striæ best seen on the cast.

Length 0·5 of an inch; height 0·4 of an inch.

Battle Creek, Mich.

This is one of the most beautiful of the Chonetes family, and is easily distinguished from all other species by the rounded ears, the inward direction of the spines, and the mesial depression to be seen only on the interior of the entering valve.

CHITON (Linnæus).—1. *C. carbonarius*, n. s. Anterior valve semicircular, broadly rounded in front, arched. Middle valve subquadrate, elevated into a well defined ridge on the dorsum ending posteriorly in an acute apex and overlapping the succeeding valve. Posterior valve rounded behind, the margin strengthened by an elevated carina of a horse-shoe shape and extending in front two-thirds of the length of the valve. The dorsum is elevated, somewhat conical, a ridge extending from the anterior edge to the middle and ending in an acute apex. From the apex the valve slopes regularly to the margin. The last seven valves have on either side of the ridge and projecting anteriorly from the lateral areas an accessory plate, which when detached is smooth, thin posteriorly, wide and round in front, where it is attached to the preceding valve. The surface of all of the valves is ornamented with fine granulations arranged in rows parallel to the margin, causing the suspicion that the living animal was spinous or hispid.

Plates, length 0·5—0·8 of an inch; shell 4—6 inches.

Modern Chitons, as is well known, have apophyses on the front, lateral margins which strengthen the attachment of the valves. The *C. carbonarius* has accessory plates which are firmly attached (anchylosed?) to the posterior plates by their acute extremities, but loosely attached by their rounded extremities to the anterior valves.

In the roof of the Danville coal.

2. *C. parvus*, n. s. Anterior valve semicircular conical. Apex pointing posteriorly, sloping regularly to the margin. Middle valves acutely subrhomboidal, scooped in front, sharp behind, dorsum elevated, terminating posteriorly in an acute apex. Posterior valve semicircular behind, abrupt in front, rising into an acute ridge, extending to the middle of the valve, terminating in an acute apex, from which the valve slopes to the margin, which is thickened and turned up. Accessory plates more broadly rounded than in the preceding species. Surface under the glass, is minutely granulated.

Length: plates, 0·1 of an inch: shell 1–2 inches.

Archimides limestone, Bergen Hill, Ind.

Appendix.

AVICULA (Klein).—1. *A. orbiculus*, n. s. Shell circular, flattened, thin, attenuated at the margins. Hinge-line straight, one half the width of the shell. Auricles small, corrugated, beak small, scarcely prominent, surface smooth.

Dimensions: height 0·75 of an inch. Width, ditto.

Position: in the calcareous shales, between the upper and lower coal series of the Appalachian system, at Summit, Columbiana Co., Ohio. In the upper black shales at Springfield, Ill.

2. *A. triplistriata*, n. s. Shell small, inequilateral, hinge-line :raight, and sloping posteriorly. Anterior auricle the largest, ordered by an elevated ridge, umbones moderate, beaks hidden. interior portion of the surface ornamented with 30 crenulated triæ for the most part arranged in triple series. The posterior ortion has 12 crenulated striæ, which are stronger than those f the anterior portion.

Dimensions: height 0·5 of an inch; width, ditto.

Position and locality: in calcareous shales at Summit Station, 'olumbiana Co., Ohio.

POSIDONOMYA (Bronn).—*P. striata*, n. s. Shell small, subdis- oidal. Hinge-line straight, nearly equal to the width of the iell. Beak? obscure, surface ornamented with 15 strong striæ, 'hich proceeding from the hinge-line, become dichotomous be- ore reaching the cardinal margin, and are crossed by numerous oncentrical lines parallel to the margin.

Dimensions: height, 0·4 of an inch; width, ditto.

Position and locality same as the preceding.

GERVILLA (Defrance).—*G. Auricula*, n. s. Shell elongated, iflated, almost cylindrical, apex appressed to the hinge-line, near ie anterior extremity which is rounded and earless. Posterior xtremity prolonged, curved, acute; posterior ear winged, reach- ig one half the width of the shell; hinge-line straight. Surface nooth, save at the anterior extremity, where a few incremental nes are visible.

Dimensions: length, 0·75 of an inch; height 0·20; length of inge-line with ear, 0·45 of an inch.

Position and locality: in the roof of Danville coal, Danville, Ill.

North Egremont, Mass., Dec. 10, 1857.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *Researches on indices of refraction.*—JAMIN has undertaken to de- rmine the refracting power of water when compressed or when reduced vapor. The experiments were executed by means of the author's very autiful apparatus for interferences described in the 42d volume of the omptes Rendus. The water examined was enclosed in two parallel bes one of which was open while the other was subject to variable essure. At every change of pressure the fringes underwent a displace- ent which was measured and from which the variations in the refracting wer of the liquid could be calculated. To avoid the error arising from e increase in the length of the compressed column, the two tubes were unged into a trough full of water, so that the interfering rays traversed e length of the tubes and the spaces separating their extremities from

the sides of the trough. If one of the tubes changes its length small quantity, the external space diminishes by the same quantit thus the effect of the dilatation is sensibly destroyed. The author that with this apparatus one millimetre of pressure, more or less, pro an interval of $\frac{1}{100}$ of a fringe which is easily observed: for an enti mosphere there is a displacement of 28 fringes. The sensibility o apparatus could be still more increased by giving the tubes a g length than that of one meter which was employed. The author that in all his experiments, the difference of path produced by pr was sensibly proportional to the pressure, so that if we calculate the pressibility of water from the optical experiments, we find the coeff to be 0·0000500 for common distilled water and 0·0000511 for deprived of air. According to the direct measures of Grassi this cient is 0·0000504. Jamin has also measured with the same instru the index of refraction for the vapor of water. Two tubes were emp 4 meters in length: one of these was filled with perfectly dry air other with air charged with a known proportion of the vapor of The difference in the refractive powers could then be observed b change produced in the fringes. There was generally a difference fringes between dry and saturated air. More than fifty measure made under very different circumstances of temperature, pressure, hygrometric condition, agreed in assigning to the refractive pow vapor at 0° and 760^{mm} the value 0·000521. The author finds fa that the diminution in the index of refraction of air by saturation vapor would only affect the seventh decimal of the nunber 1·00029 found for that index, and that consequently in astronomical refracti is useless to trouble oneself about the vapor of water.—*Comptes Re* xlv, 892.

2. *On the density of the vapors of certain bodies.*—Deville and Tr have communicated to the Academy of Sciences a memoir on the ties of the vapors of certain chlorids which possesses great int The authors employed in their experiments a new and ingenious m which appears in point of accuracy and convenience to leave little desired. The principle of this method consists in plunging the ba containing the substance into the vapor of some other substance boils at a high temperature without decomposition. In this mann thermometer is necessary. The authors employ for this purpose su and mercury, the former boiling according to Dumas at 440° C., an latter at 350°. The apparatus used consists of a mercury bottle near the neck so as to form a cylinder closed at the bottom. In the rior there are two diaphragms pierced with holes, which serve to hol balloon at a height of 6 or 8 centimetres above the bottom of the l To cut off the furnace heat from the vapor cylindrical laminæ are p parallel to the sides of the bottle. The upper part is closed by mea a plate of cast-iron provided with two holes, through one of which the narrow neck of the balloon, and through the other the stem air thermometer which need not be graduated and which serves on indicate the constancy of the temperature. The authors subsequ omitted the thermometer as unnecessary. An iron tube is attach the upper part of the bottle to carry off the vapor of the mercury o phur for condensation; one kilogram of sulphur and one or two

grams of mercury are usually employed. In this manner the following densities were determined. Sesquichlorid of aluminum in the vapor of mercury 9·35; in the vapor of sulphur 9·34: the calculated density ($Al_2\ Cl_3$=2 vols.) is 9·31. The density of sesquichlorid of iron was found to be 11·39; the calculated density ($Fe_2\ Cl_3$=2 vols.) is 11·25. Protochlorid of mercury gave a density of 8·21=4 vols.: Mitscherlich found 8·35. The density of the sesquichlorid of zirconium was found to be 8·15 which leads to the formula $Zr\,Cl_2$=2 vols. for this chlorid. The authors propose to employ the vapor of zinc instead of that of sulphur or of mercury, and to use porcelain balloons which can be sealed up by the oxhydrogen blowpipe. Chemists will anxiously await the result of these experiments which promise to be of great theoretic value.—*Comptes Rendus*, xlv, 821.

3. *Memoir on the equivalents of the elements.*—DUMAS has presented to the Academy of Sciences a very interesting paper upon the equivalents of the elements which not merely contains several re-determinations of the equivalents themselves, but points out remarkable numerical relations between the atomic weights of bodies belonging to the same natural group. The author gives the following as the results of his numerical determinations:

Silver, 108	Fluorine, 19	Tungsten, 92
Chlorine, 35·5	Selenium, 40	Manganese, 26
Bromine, 80	Tin, 59	Boron, 11
Iodine, 127	Molybdenum, 48	Silicon, 21.
Sulphur, 16		

The equivalent of silver was calculated from Marignac's analyses by taking nitrogen = 14 and oxygen = 8. To determine the exact number for chlorine the author heated weighed quantities of silver in a current of chlorine gas, maintaining the temperature until the resulting chlorid was completely fused. This very beautiful method requires but three weighings and leads precisely to the number 35·5. The equivalents of bromine and iodine were determined by heating weighed quantities of bromid and iodid of silver in a current of chlorine and fusing the resulting chlorid. These numbers agree with those found by Marignac. The equivalent of fluorine was determined by the analysis of a very pure native fluor spar as well as by that of crystallized fluorids of sodium and potassium. The number 16 for sulphur was verified by burning a known weight of silver in a current of the vapor of sulphur. Direct experiments on the formation of chlorid of selenium gave the number 40 for the equivalent of that element: the author thinks that the difference between his result and that of Berzelius is due to the fact that he was able to employ a purer selenium. The equivalent of tin was found by the method of Berzelius, that is to say, by heating the bichlorid with nitric acid and igniting the resulting stannic acid. The acid ignited in a mattrass of hard glass gave precisely the equivalent found by Berzelius, viz., 58·8, but on ignition in a platinum crucible the oxyd loses traces of water, and after this correction the equivalent becomes 59. The equivalent of molybdenum was determined by igniting molybdic acid in a current of hydrogen and was found to be 48. [This result differs by two entire units from that of Svanberg and Struve who found 45·92, and from that of Berlin who found 45·98.—W. G.] The equivalent of tungsten was

determined in a similar manner. [The author's result in this case agrees with those of Schneider and Marchand.] In the case of manganese the number 26 was found by igniting an artificial binoxyd in a current of hydrogen so as to reduce it to protoxyd. [Dumas' equivalent for manganese differs so greatly from that of Berzelius, 27·6, as to make further researches desirable.—W. G.] The number 11 for boron is calculated from recent analyses of the chlorid by Deville: that of silicon was determined by analyses of the chlorid and found to be between 21 and 21·2. The author found it however impossible to remove from the chlorid traces of chloroxycarbonic acid which it holds in solution, and the presence of which is easily shown by agitating the chlorid with water when carbonic acid gas is disengaged.

The author is still engaged with the subject of a revision of the equivalents and the publication of his results—which cannot be looked for till the close of the present year (1858)—will be awaited by chemists with special interest.

In order to exhibit the numerical relations between the equivalents of the different elements the author, after referring to the previous investigations of Prof. Cooke, takes up in the first place the examination of certain groups and series presented by organic chemistry. If we consider the homologous series C_2H_3, C_4H_5, C_6H_7, &c., we remark at once that there is a common point of departure for and a common difference between the equivalents of the successive terms. The formula $a+nd$ represents the generation of all these radicals, a being the equivalent of the first, and d the difference between the first and second term. The author remarks that if we did not know the law of progression we might easily be led to think that the ratio between the numbers 141 and 281, 127 and 253, 113 and 225, is the simple ratio of 1 : 2, especially as chemistry can hardly decide with absolute certainty whether an element has, for example, the equivalent 225 or 226. The formula deduced from the simple progression above mentioned would not account for the generation of the elements as Prof. Cooke supposed. But the organic radicals are not always produced by addition but sometimes by substitution as we see in the compound ammoniums. We may have for instance the following ammoniums:

$$\begin{array}{lllll}
a & a+d & a+2d & a+3d & a+4d \\
 & a+d' & a+d+d' & a+2d+d' & a+3d+d' \\
 & & a+2d' & a+d+2d' & a+2d+2d' \\
 & & & a+3d' & a+d+3d' \\
\end{array}$$

$$a+d+d'+d''+d''',$$

where a represents ammonia NH_4, and d, d', &c. represent the equivalent of hydrocarbons of the series CnHn.

In the next place there are certain radicals in organic chemistry where the fundamental molecule itself changes as well as the bodies added to or substituted in it. Thus tin and ethyl form six molecular groups possessing all the properties of organic radicals. If we represent tin by a and ethyl by d' we have for the six species of stannethyl the formulas

$$\begin{array}{lll}
a+d' & 2a+d' & 4a+d' \\
 & 2a+3d' & 4a+3d' \\
 & & 4a+5d' \\
\end{array}$$

ɔeing the general formula. With these premises the author compare the equivalents of the elements. The elements F, o not form a single progression. The relation between their is however exhibited by the scheme a, $a+d$, $a+2d+d'$, d', or in numbers,

Fluorine, - - -	19
Chlorine, - - - -	$19+16{\cdot}5=35{\cdot}5$
Bromine, - - -	$19+33+28=80$
Iodine, - - - -	$38+33+56=127$.

hosphorus, arsenic, antimony and bismuth form another natu- and for their equivalents we have the scheme, a, $a+d$, $a+d+2d'$, and $a+d+4d'$, or in numbers,

Nitrogen, - - -	14
Phosphorus, - - -	$14+17=31$
Arsenic, - - -	$14+17+44=75$
Antimony, - - -	$14+17+88=119$
Bismuth, - - -	$14+17+176=207$.

r gives similar series for carbon, boron, silicon, and zirconium, for tin, titanium and tantalum, which we omit. For oxygen, enium, and tellurium we have either of the series a, $2a$, $5a$, $+d$, $a+4d$, $a+7d$. Analogy points out the latter as prefera- have in numbers,

Oxygen, - - -	8
Sulphur, - - - -	$8+8=16$
Selenium, - - -	$8+32=40$
Tellurium, - - -	$8+56=64$.

ı difference of 8 also connects Mg, Ca, Si, Ba, Pb; thus we

Magnesium, - - -	12
Calcium, - - - -	$12+8=20$
Strontium, - - -	$12+32=44$
Barium, - - - -	$12+56=68$
Lead, - - - -	$24+80=104$.

ɔdium and potassium belong to a similar series with a common ɔf 16.

Lithium, - - -	7
Sodium, - - - -	$7+16=23$
Potassium, - - -	$7+32=39$.

m, tungsten, chromium, and vanadium form a similar series of common difference is 22, the progression being 26, 48, 70, 92. r considers his results as favorable to the idea of Dr. Prout, sed the equivalents of all the elements multiples by a whole that of hydrogen. In the case, however, of chlorine and per- ne other elements the unit of reference is less than the equiv- drogen and is probably 0·5. In all the series the first member the chemical character of all the other terms. These consid- he author remarks, will have more weight when he presents ɔf a natural family of which hydrogen is the first term, and

exhibits the connection between the physical properties of the elements and the position which each occupies in the series of which it forms a member.—*Comptes Rendus*, xlv, 709, *Nov.*, 1857.

4. *On new compounds of silicon.*—Buff and Wöhler have continued their investigation of the compounds of silicon with chlorine, &c., and have arrived at many interesting results. When crystalline silicon is heated below redness in a current of chlorhydric acid, a volatile liquid is formed which appears to be a mixture of various compounds. On distillation this liquid usually begins to boil at 28° or 30° C.; the temperature rises, however, rapidly to 40°–43°, when the greater portion of the liquid passes over. The boiling point finally rises to over 60°, and in one case even to 92°.

The new chlorid is a colorless mobile liquid of a penetrating smell, fuming strongly in the air and covering everything around with a white deposit. Its boiling point is 42° C. and its density 1·65: these numbers however are only approximately accurate. The liquid is a non-conductor of electricity; its vapor is as inflammable as that of ether, and it burns with a faintly luminous greenish flame, giving off silica and chlorhydric acid. The vapor of the chlorid explodes with oxygen very violently: the residual gas is fuming and consists of the ordinary chlorid and chlorhydric acid, so that half the silicon is oxydized to silicic acid. When the vapor of the new chlorid is conducted through a narrow glass tube heated to redness, it is very easily decomposed, giving a brown film of amorphous silicon. Fused aluminum also decomposed the chlorid with great ease, hydrogen being set free, chlorid of aluminum formed and silicon deposited. Water decomposes the chlorid immediately into muriatic acid and a white oxyd which differs greatly from silica in not being gelatinous. The author's analyses lead directly to the formula Si_2Cl_3+2HCl, so that the new substance is not properly a chlorid of silicon as at first supposed.

A corresponding bromine compound may be prepared in a precisely similar manner, and is a colorless fuming liquid. The iodine compound Si_2I_3+2HI is a dark red brittle mass which fumes in the air, becoming at first cinnabar-red and finally snow-white. It melts easily and becomes crystalline on cooling; it may be distilled without decomposition. Bisulphid of carbon dissolves it in large quantity with a blood-red color; from this solution it crystallizes on concentration.

The hydrated sesquioxyd Si_2O_3+2HO is a snow-white amorphous body: it is very light and voluminous and floats upon water. Alkalies and their carbonates, and even ammonia, dissolve it with strong effervescence of escaping hydrogen to silicates. Acids in general exert no action, but fluohydric acid dissolves it with evolution of hydrogen. The hydrate may be heated to 300° without losing its water or otherwise changing. When more strongly heated, it ignites and glows with a phosphorescent light, while hydrogen is given off and burns with explosion.

When heated in oxygen it burns brilliantly. When heated in a tube it gives off a gas which fumes in the air but does not inflame, and which appears to be a mixture of spontaneously inflammable siliciuret of hydrogen and hydrogen. The hydrate is slightly soluble in water and is a powerful reducing agent, reducing selenious and tellurous and even sul-

hurous and hypermanganic acids. The authors have made several ob- ›rvations which render it probable that there is a lower chlorid than that lready described, and consequently also a lower oxyd. In one case an xyd was obtained which appeared to have the formula Si_2O_4+3HO. Vhen amorphous silicon is used instead of the crystalline in the prepa- ation of the chlorid scarcely any liquid chlorid is obtained, but only a as which on condensation in water gives an oxyd containing 52·75 per ent of silicon, and which burned more brilliantly than any other. This ercentage is nearly 2 p. c. higher than that in the hydrated sesquioxyd. 'he authors further remarked in one case the existence of a chlorid 'hich when mixed with air exploded on gentle heating. Chemists will 'ait the final results of this important investigation with especial interest. –*Ann. der Chemie und Pharmacie*, civ, 94.

5. *New Researches on Boron.*—Wöhler and Deville have communi- ated to the Academy many additional facts of interest in relation to the hemical history of boron. To obtain amorphous boron the authors mix 00 grams of fused and coarsely powdered boric acid with 60 grams of odium and project the mixture into a red-hot cast-iron crucible. The 'hole is then covered with 40 or 50 grams of fused common salt and ie crucible closed. After the reaction, the fused mass is stirred with an on rod, and the fused mass poured into water acidulated with chlorhy- ric acid and contained in a deep vessel. On filtering, the boron remains n the filter and is to be washed first with acidulated and then with pure 'ater. The boron may now be dried upon a brick at ordinary tempera- ıre, as it might otherwise take fire and burn rapidly. Amorphous boron ıay be transformed into crystalline boron by lining a crucible with it nd putting in a piece of aluminum. At a high temperature the alumi- um becomes charged with boron from which it is easily separated by cids. In this experiment the boron which has not undergone the trans- ›rmation is found to have become white, and to have absorbed nitrogen 'hich has passed through the walls of the crucible. Boron heated in a urrent of ammonia appeared to take fire, nitruret of boron being formed 'hile hydrogen is set free. This nitruret when treated with caustic pot- sh disengages torrents of ammonia. Boron heated in a current of nitro- en forms the same white infusible compound, and a similar result is ob- ained when a mixture of charcoal and boric acid is heated in a current f nitrogen or of ammonia. From all this it appears that it is impossible › heat boron in ordinary crucibles or furnaces without the formation of a itruret. The only mode of overcoming the difficulty consists in sur- ›unding the crucible containing the boron with a mixture of rutile and arbon, in which case the nitrogen is absorbed by the free titanium.

At a red heat amorphous boron decomposes the vapor of water, boric cid and hydrogen being formed. Sulphid of hydrogen is also decom- osed by boron with disengagement of hydrogen and formation of a sul- hid. Chlorhydric and bromhydric acids are decomposed under the same ircumstances. The chlorid thus formed is that already well known, but ıis and the bromid are not gases, as heretofore supposed, but volatile quids, the chlorid boiling at 17° C., and the bromid at 90° C. Their apor-densities correspond to 4 volumes. There is also an oxychlorid, an xybromid, an oxyiodid and an oxyfluorid, which however are not de- :ribed in the notice before us.

Amorphous boron reduces the chlorids of mercury, lead, and silver, at a high temperature with production of chlorid of boron. Galena is reduced in a similar manner, metallic lead being set free and a sulphid of boron formed. In conclusion the authors direct attention to the fact that nitrogen, hitherto considered a passive and inert substance, may under certain circumstances become an active agent. They announce the discovery of a simple mode of preparing the nitruret of silicon which will form the subject of another memoir.—*Comptes Rendus*, xlv, 888. W. G.

6. *On the Magnetic Induction of Crystals;* by Professor Julius Plücker of Bonn, For. Memb. R. S., Hon. M.R.I., &c. (Proc. Roy. Soc. in Phil. Mag., vol. xiv, p. 477).—The author commences by referring to his discovery of the peculiar action of magnets on crystalline bodies, and to the researches to which he was thereby led. With reference to the form in which he enunciated the law regulating the action of a magnet on a uniaxal crystal—that the optic axis is attracted or repelled by the poles of the magnet—he disclaims any intention of assigning a physical cause to the phenomenon, or doing anything more than expressing the results of observation, which are *as if* such a force existed. In the case of crystals of a more complicated character, he was led, in the first instance, to assume the existence of two magnetic axes, possessing a similar character as to attraction and repulsion with the one axis of optically uniaxal crystals. But finding that the proposed law did not hold when the crystal was examined in all directions, and not solely along peculiar axes, he abandoned, nearly two years ago, a hypothesis respecting which serious doubts had arisen long before. For the hypothesis of one or two axes acted upon by the magnet, he substituted another similar hypothesis. In the case of uniaxal crystals he now conceived an ellipsoid of revolution, consisting of an amorphous paramagnetic or diamagnetic substance, and having within the crystal its principal axis coincident with the principal crystallographic axis. It is easy to verify that both crystal and ellipsoid, the poles of the magnet not being too near each other, will be directed between them in exactly the same way. In the generalization, an ellipsoid with three unequal axes, having a determinate direction in the crystal, must be substituted for the ellipsoid of revolution. In this hypothesis too, two "magnetic axes" are met with, that is, according to the new definition, directions which possess, in common with the single crystallographic axis of uniaxal crystals, the property that if the crystal be suspended so that either of these axes is vertical, and the body is at liberty to turn freely round it, no extraordinary magnetic action is exhibited, but the crystal behaves like an amorphous substance.

According to observation, a crystal under favorable circumstances is directed in the same way as the smallest of its fragments. Hence, according to the new hypothesis, each of its particles may be regarded as acted on like an amorphous ellipsoid. But such an amorphous molecular ellipsoid, when influenced by a magnetic pole at a finite distance, will be directed like an ellipsoid of finite dimensions under the influence of an infinitely distant pole. Here Poisson's theory presented itself for the verification of the hypothetical conclusions and their consequences, to which the author had been led by considerations of a different kind. This verification had the most complete success. But before proceeding to it, it was found necessary to confirm Poisson's theory itself (or rather

ıe results following from it), with respect to an ellipsoid of finite dimen-
.ons influenced by an infinitely distant pole. By means of a beautiful
ıeorem lately published by Professor Beer, by which the results relating
ı the influenced ellipsoid are simply and elegantly expressed by means
f an auxiliary ellipsoid, the author was enabled to deduce immediately
ıe analytical expressions. These were afterwards compared with ex-
eriment, by observations made on two carefully worked ellipsoids of soft
on, executed by M. Fessel of Cologne.

The results thus obtained from theory, and verified by experiment, ith reference to an amorphous ellipsoid, were compared with the results btained from the observation of crystals, and manifested a complete greement. According to this theory, the magnetic induction within a ystal is, like the elasticity of the luminiferous ether, determined by ıeans of an auxiliary ellipsoid. As there are three rectangular axes of ɔtical elasticity, so there are three principal axes of magnetic induction, ıaracterized by the property that if a crystal be suspended along any ıe of them, the two others set, one axially, and the other equatorially. s there are two optic axes, situated in the plane of the axes of greatest ıd least elasticity, so there are two magnetic axes, characterized by the roperty already mentioned.

Among crystals, the author selected for special examination red ferro- anid of iron, sulphate of zinc, and formiate of copper. The first is ıramagnetic, the second diamagnetic, and in both cases the principal ces of magnetic induction are determined by the planes of crystalline mmetry. The setting of elongated prisms, as well as of long cylinders ıd short cylinders or circular plates, cut in various selected directions ɔm the crystals, is described in detail. The use of both cylinders and rcular plates, cut with their axes in the same direction, obviated any ob- ction which might be raised attributing the setting to the external form, nce, so far as was due to mere form, a cylinder and a circular plate ould set with their axes in rectangular directions.

Formiate of copper differs from the former crystals in having but one ane of crystalline symmetry, and accordingly in having but one princi- ıl axis of magnetic induction determined by the crystalline form. The istence of three principal magnetic axes, having the property already entioned, was demonstrated experimentally, and the directions of those o which were not determined by the crystalline form, were ascertained experiment. In this crystal the axes of greatest and least induction, ıd consequently the magnetic axes, lie in the plane of symmetry; and e existence of two magnetic axes was demonstrated, and their positions ere determined.

In conclusion, the author gives a list of crystals, classified according to eir paramagnetic or diamagnetic characters, and the order of magni- de of the magnetic inductions in the direction of their principal axes. e also remarks that some crystals, of which instances are given, though longing according to their form to the biaxal class, have two of their incipal magnetic inductions so nearly equal that they cannot be distin- ished from magnetically uniaxal crystals; while others, though not be- ıging to the tesseral system, have all their principal inductions so nearly ual that they cannot be distinguished from amorphous substances.

II. GEOLOGY.

1. *Quarterly Journal of the Geological Society*, No. 52.—The most important memoir in this number is one by Dr. Falconer *on the Species of Mastodon occurring fossil in Great Britain*, which is to be followed by another on the species of Elephant. The author reviews the generic distinctions and nomenclature of the Proboscidea in general, and then enters upon the fossil Mastodon of Great Britain. The number of existing species of Proboscideans is but two, while of extinct species thirteen are enumerated. Dr. Falconer subdivides both the genera, Elephas and Mastodon, according to the teeth, remarking, at the same time, that the two groups graduate into one another in the forms of these parts. The two subgenera of Mastodon are *Trilophodon* and *Tetralophodon*, the first having *three* ridges to the intermediate molars, the latter *four*. The subgenera of Elephas are *Stegodon* (approaching the Mastodons most closely), *Loxodon* and *Euelephas*. Of the extinct species, the Miocene has afforded *Trilophodon tapiroides* (Europe), *T. angustidens* (in "immense abundance" in France, Germany, Switzerland), *T. pyrenaicus* (Europe); *Tetralophodon longirostris* (Europe), *Tet. latidens* (Southern India), *Tet. Perimensis* (Southern and Western India), *Tet. Sivalensis* (India); *Stegodon Cliftii* (= Mastodon latidens of Clift in part, Southern India, Ava), *S. bombifrons* (India and Sewalik Hills), *S.? Ganesa* (ibid), *S. insignis* (ibid); *Loxodon planifrons* (ibid); *Euelephas Hysudricus* (ibid). In the Pliocene have been found, the *Trilophodon Borsoni* (Europe, Southern India); *Tetralophodon Arvernensis* (England and Europe); *Stegodon insignis* (see above), *Loxodon meridionalis* (England and Europe), *L. priscus* (England and Lombardy); *Euelephas antiquus* (England and Europe), *E. Nomadicus* (Central India). Probably of the Pliocene, are the *Trilophodon Pandionis* (Southern India), and the *Tetrolophodon Andium*. To the Postpliocene belong, *Trilophodon Ohioticus*, Blumb. (= Mastodon giganteus, North America), *Euelephas primigenius* (Europe, Asia and North America). The *Trilophodon Humboldtii* (South America), and *Euelephas Columbi* of Mexico, Georgia and Alabama, (to which *E. Jacksoni*, described in Amer. J. Sci., 1838, xxxiv, 363, is referred with a query,) are regarded as probably Postpliocene.

The British species of Mastodon is the *Tetralophodon Arvernensis*. It occurs in what is called the Older Pliocene "Red Crag," at Felixstow and Sutton in Suffolk, and in the Newer Pliocene "Fluvio-marine" or "Mammaliferous Crag" in various localities near Norwich in Suffolk, and is associated with the remains of the Elephant, *Loxodon meridionalis*. Dr. Falconer discusses the age of these deposits and concludes that they are alike pliocene, and agree with the great pliocene Fauna of Italy as exhibited along the valleys of the Po and Arno. The mixed contents of the Red Crag, including Mammalian remains of different strata from the Eocene period upwards (which have led to the suspicion of an earlier age) are inferred to have been deposited in the reconstructed strata, also within the Pliocene period. "The Red Crag sea appears to have breached a previously established and populated Pliocene land, and to have buried the bones referable to various epochs in the same sea bottom."

This paper by Dr. Falconer is preceded by the able anniversary address of the President Colonel J. E. Portlock—a review of various geological papers published during the year preceding, and occupying 123 pages. Following it, there is an article by Prof. T. H. Huxley, on a new Crustacean of the Lias bone-bed at Aust Passage, which is macroural or anomoural, probably the latter, and is named *Tropifer lævis*. Also another species from the Coal Measures at Medlock Park Bridge, named *Pygocephalus Cooperi*, which he regards as related to the Squillidæ.

2. *Annual Report of the Geological Survey of the State of Wisconsin*, for the year ending Dec. 31, 1857; by EDWARD DANIELS, Geologist. 62 pp., 8vo. Madison, 1858.—This Annual Report by Mr. Daniels, for 1857, treats briefly of some Iron Ores of Wisconsin. 1st. The red argillaceous or "seed ore" of Dodge County, which is believed to belong to the same age as the Clinton group, like the similar ore of Central New York. The bed is generally ten to fifteen feet thick; it lies between a massive grey limestone above, equivalent to the Niagara and Clinton groups and a soft blue shale of the age of the Hudson river group. An analysis of the ore by Dr. C. T. Jackson afforded peroxyd of iron 72·50, lime 0·56, oxyd of manganese 1·40, alumina 8·40, magnesia 0·64, silica 7·75, water 8·75 = 100. The same kind of ore occurs also at Hartford, Washington Co., fourteen miles southeast of Iron Ridge, where the bed is six to seven feet thick; and in the town of Depere, eighty miles north-northeast of Iron Ridge, six and a half feet thick.

2nd. Magnetic and specular iron ores, in Azoic or crystallized rocks. They occur at Black River Falls, in chloritic and micaceous schists, over which in some parts of the region the Potsdam sandstone occurs, resting nearly or quite horizontally on the upturned edges of these schists. The ore is conformable to the lamination of the schists and is sometimes banded with quartz; the beds are six to forty feet wide, occurring in several alternations, and are inexhaustible. They are related in character to those of the Lake Superior region described by Foster and Whitney, and also to those of Northern New York.

3d. Specular and titaniferous ores occur in Baraboo valley in quartzite which is the hardened Potsdam sandstone. It is laminated, slightly waving, and has a high lustre; it is slightly magnetic. The ore is not abundant.

4th. At Ironton, in the town of Marston, Sauk County, hydrated oxyd of iron (limonite) occurs in the Potsdam sandstone. The bed averages five feet in thickness.

3. *On the Newer Pliocene and Post-pliocene deposits of the vicinity of Montreal*; by J. W. DAWSON, LL.D., Principal of McGill College, (Canadian Naturalist and Geologist, ii, 401.)—Mr. Dawson has added much by his labors to our knowledge of the Post-pliocene deposits of the St. Lawrence valley about Montreal. In his paper, he reviews the facts before known and gives descriptions of some new fossils and their localities, together with general remarks on the region. We cite some of the statements.

The mountain back of Montreal has strongly marked sea-margins at heights of 470, 440, 386, and 220 feet above Lake St. Peter on the St. Lawrence (or 450, 420, 366, and 200 above the river at Montreal). The highest contains sea shells of existing species.

One hundred feet below the lowest spreads the plain of Lower Canada, containing abundant marine shells, all of them, with one or two exceptions if any, recent. It consists (1.) of a sand deposit, sometimes gravelly beneath, and containing marine shells in its lower part; (2.) an unctuous calcareous clay, with some marine shells; (3.) compact boulder clay, filled with stones of the crystalline rocks, usually partially round and often scratched and polished.

The trap boulders derived from the Montreal mountain, as Dr. Bigsby early pointed out, were drifted southwest, and have been traced 270 miles to the south shore of Lake Ontario. But the terraces are most distinct on the northeast side. Under the boulder clay the surfaces are striated, and northeast of Montreal mountain, the directions observed were S. 70° W., to S. 50° W.

The deposits of the plain appear to be in part at least of littoral or shallow water origin. This is indicated for the upper layer, near the Tanneries, by the great numbers of *Saxicava rugosa.* But the clay below abounds in *Nucula (Leda) Portlandica*, which probably lived in muddy bottoms 10 to 15 fathoms in depth. The same arrangement is observed at other localities. Mr. Dawson names the upper layer the *Saxicava sand*, the lower the *Leda clay.*

From the Leda clay near St. Denis, at the cutting of the Montreal and Ottawa railway, Sir W. E. Logan has obtained a number of caudal vertebræ of a Cetacean, part of the pelvis of a seal, and fragments of wood of the cedar (Thuja occidentalis). At one locality, the following species were obtained from the upper layer: (we indicate below by an asterisk the species not before reported as Canadian :) *Tellina Groenlandica, Saxicava rugosa, Mya arenaria, Mytilus edulis, Astarte Laurentiana, Tellina calcarea, Trichotropis borealis, Fusus borealis, Fusus tornatus,* Bulla Oryza,* Leda Portlandica.* At another, near the house of James Logan, Esq., "an intermediate deposit," the above occur along with *Balanus crenatus* (*B. miser* of some lists), *Mya truncata, Spirorbis sinistrorsa** (on stones and valves of Mya truncata), *Natica clausa, Buccinum ciliatum,* B. undatum, Admete viridula,* Acmæa cæca,* Nucula minuta, Lacuna neritoides,* Natica helicoides?* Fusus scalariformis,* Serpula vermicularis,* Margarita arctica,* Modiolaria discors, Rissoa minuta,* Bulla debilis?* Trichotropis arctica,* Cytheridea Mulleri?* Velutina zonata?* besides several species of Foraminifera,* masses of siliceous spicula of a sponge (Tethæa*). From the associated shells it appears that the celebrated locality of the Capelin (*Mallotus villosus*) and Lump-sucker (*Cyclopterus Lumpus*), at Green's Creek on the Ottowa belongs to this level, its elevation being 118 feet above Lake St. Peter; it has afforded also small specimens of *Leda pygmæa;* remains of probably an Ophiura-like Starfish;* also of the plants *Populus balsamifera** and *Potentilla Norvegica** with Algæ.* *Fusus harpularius, Menestho* (Chemnitzia) *albula, Amicula vestita* (Chiton Emersonii of Gould), and *Leda minuta,* are other reported species of the Canada post-tertiary.

The locality at Beauport near Quebec, described by Captain Bayfield and Sir C. Lyell, belong to this same level, and has afforded, besides others already named, the following not enumerated above: *Balanus Hameri, Natica Groenlandica,* Natica Heros,* Turritella erosa,* Scala-*

[redacted]

'a *Groenlandica*, *Littorina palliata*, *Cardium Groenlandicum*, *Cardium* *ılandicum*, *Pecten Islandicus*, *Rhynconella psittacea*, *Echinus granulatus*.

A locality at St. Nicholas, fifteen miles above Quebec, on the south de of the St. Lawrence at an elevation of 180 feet, 400 yards from the ver, has afforded *Tellina calcarea* (most abundant and large), *Balanus Iameri* (abundant), *Mya truncata*, *Saxicava rugosa*, *Astarte Laurentiana*, *Trichotropis borealis* and *Buccinum undatum*. The bed—of hardned clay—was probably formed in deep water.

At the terraces of 220 and 386 feet on Montreal mountain no shells ave been found. But westward of Montreal, near Kemptville, Sir W. L. Logan has found littoral shells at 250 feet above Lake St. Peter. nother locality in Winchester is 300 feet; another in Kenyon 270 feet; wo others in Locheil 264 and 290 feet; at Hobbes Falls, Fitzroy, at 350 ›et; at Dulham Mills on the De L'Isle, at 289 feet above the St. Lawınce; on the Portland and St. Lawrence railroad, near Upton Station, at 57 feet; still farther east, on the river Gouffre, near Murray Bay, at 180 nd 360 feet above high tide.

The terrace of 470 feet, the highest observed, consists of (1) 8 feet of ngular stones and sand; (2) fine gravel with shells principally Saxicava ıgosa, 5½ feet; (3) 6 feet of stratified sand with few shells. On the ›ttawa, in the 4th concession of Nepean, Logan has found a similar each at 410 feet. "On the west, the highest terrace observed by the U. . Geologists on the south side of Lake Ontario, appears to correspond ·ith this sea level, and the gravel and sands containing elephantine reıains near Hamilton, may have been washed into its western extremity om the neighboring land." Marine shells have not yet been found west f Kingston.

Among the shells, *Leda Portlandica* and *Astarte Laurentiana* belong › the Leda clay, and are suspected to be extinct, the first, if recent, is ated to be the *L. truncata*, and the other the *A. sulcata*. All the deosits overlie the inferior or "unmodified drift."

This valuable paper is accompanied by two plates, containing figures f several of the species noticed.

4. *Crinoids of New York*.—We have received some sheets of Prof. ames Hall's forthcoming (third) volume on the Palæontology of New 'ork; and learn that it is making rapid progress towards completion. 'he volume will include the fossils of the Lower Helderberg Rocks or the pper part of the Upper Silurian, and the Oriskany Sandstone, generally ›garded as Devonian. The author remarks that the subdivisions of the ›ower Helderberg beds (into Upper Pentamerus limestone, Encrinal mestone, Delthyris shaly limestone, Pentamerus limestone and Tentacute or water limestone) are distinguishable only for a short distance, 'hile the formation as a whole reaches widely from the northeast to the ›uthwest. The Oriskany Sandstone appears in some places to pass into he Helderberg rocks below, and in Maryland some of the fossils of the ıtter beds occur in it; and they may yet prove to blend intimately. But ıe separation of them in successive groups, "is fully justified by their hysical condition in the State of New York."

In the southwest, the Oriskany sandstone contains many Crinoids simiır in genera to those of the Lower Helderberg limestones. Among the

peculiar forms in both, is the genus Edriocrinus (Hall)—"a crinoid which is sessile in its young state and firmly attached to other bodies by the base of its cup, but becomes free as it advances and gradually loses all evidence of a cicatrix; the base becoming rounded and smooth, or very rarely preserving a depression or pit near the centre, which marks the original point of attachment.

The following is a list of the genera and number of species of Crinoidea and Cystidea in the Clinton and Niagara groups, and the Lower Helderberg and Oriskany Sandstone.

1. *Clinton and Niagara groups.*—Closterocrinus 1, Glyptocrinus? 1, Homocrinus 2, Glyptaster 1, Thysanocrinus 4, Dendrocrinus 1, Ichthyocrinus 1 (+ 1?), Lyriocrinus 1, Lecanocrinus 4, Saccocrinus 1, Macrostylocrinus 1, Eucalyptocrinus 3, Stephanocrinus 2, Caryocrinus 1, Melocrinus 1; Heterocystites 1, Callocystites 1, Apiocystites 1, Hemicystites 1; Palæaster 1.

2. *Lower Helderberg Group and Oriskany Sandstone.*—Homocrinus 1, Mariacrinus 8, Platycrinus 4 (the first occurrence of this genus); Aspidocrinus 2, Edriocrinus 2, Brachiocrinus 1, Coronocrinus 1; Anomalocystites 1, Sphærocystites 1, Apiocystites (=Lepadocrinus) 1; Protaster? 1.

The new genera are:

Mariacrinus,—the Astrocrinites of Conrad but not of other Authors. —Basal or pelvic plates four. Radial plates three in five series (3×5). Interradial plates three or more. Anal plates numerous. Brachial plates two resting on each third radial; beyond this point the structure differs in different species. Surface of plates marked by elevated radiating striæ or ridges which are more or less prominent, or by nodes or short spines. Arms varying in structure in different species. Resembles most *Glyptocrinus.*

Brachiocrinus.—Body unknown or none. Arms composed of numerous articulations arranged in single consecutive series (or of pentagonal joints in double series?). Base of arm rounded, without articulating surface. Tentacula composed of thickened node-like joints.

Edriocrinus.—Body subconical. Base solid, without division into plates: upper margin marked by six angles, with depressions between for insertion of radial plates. Radial plates five, inserted in the five larger depressions on the upper edge of the calyx. Anal plates two, the lower one inserted in the smaller of the six impressions on the upper margin of the calyx; the second anal plate placed on the upper edge of the first. Brachial plates numerous, consisting of thin plates in consecutive series resting upon the upper concave edges of the radial plates: pinnules subdivided above. Tentacula unknown. Proboscis unknown. Column none.

Aspidocrinus.—Base broadly circular, depressed hemispheric or scutelliform: upper margins plain or plicate exteriorly; the articulating edges irregular. Radial plates and arms unknown. Point of attachment for column distinct, small. The specimens are broad scutelliform bases of Crinoids, sometimes near hemispherical.

Coronocrinus.—Body very broad, hemispherical? towards the upper margins composed of numerous plates. Arms numerous, proceeding from the upper margin of the body: summit flat, composed of numerous small plates. Column and base unknown.

Sphærocystites.—Body spheroidal, wider than high. Arms in two principal pairs, with numerous bifurcations. Brachial sulci obliquely lobed. Mouth longitudinal? apicial: anus subapicial: ovarian opening upon the summit. Basal plates four; those of the series above not determined. Base depressed. Column unknown. The species have the general aspect of Callocystites or Lepadocrinus.

Anomalocystites.—Body semielliptical or semiovoid: sides unequal; the vertical outline oval or ovoid, plano-convex or concavo-convex; the transverse outline semielliptical, the base of which is straight or more or less concave: the two sides composed of an unequal number of plates. Basal plates three on the convex side, two on the concave side: second series, two large plates at the angles, and four (or five?) on the convex side; third series, four on the convex side, one at each angle, and a large plate on the concave side; a fourth, fifth, and sixth series of plates on the convex side, and a fourth series on the concave side. Base oblique, with the convex side longer, and a deep concavity for the insertion of the column. Pectinated rhombs apparently none. Arms unknown. Column deeply inserted into the body, composed of large joints above, becoming smaller below.

Lepadocrinus, noticed in the Annual Report of Mr. Conrad for 1840, is the same as Apiocystites, and has the priority of this last name in time.

5. *On the Cervus euryceros;* by Prof. De Morlot, (Proceed. Imp. Geol. Instit. Vienna, June, 1857, in Quart. Journ. Geol. Soc., vol. xiii, p. 35.)—M. de Morlot thus announces the discovery, by MM. Uhlmann and Jahn, of remains of the gigantic Elk (*Cervus euryceros* = *Megaceros hibernicus*) in association with works of human industry. On partially draining, in 1856, a small lake near Moosseedorf (Canton of Berne), an area of about 70 feet in length and 50 feet broad along the bank of the lower extremity of this lake was found to be paved more or less closely with posts of oak, aspen, birch, and elm, driven through two beds of peat into the marly bottom of the lake. A peat-bed, 3 or 4 feet thick, of exclusively vegetable origin in its upper part, includes many relics of human industry and art in its lower portion. Dr. Uhlmann collected nearly a thousand specimens; viz., fragments of pottery, stone-chisels, stone-arrowheads, pieces of cut bones, and perforated bear-teeth, without any traces of metallic objects. The lower ends of the posts have evidently been also worked into their pointed shape by means of stone-tools. The upper portion of the bed containing these remains exhibited traces of combustion and contained carbonized grains of barley.

Together with the above-mentioned works of art were found many fragments of the bones both of domesticated and of wild animals; viz., horned cattle, horses, swine, dogs of various size, goats, sheep, cats, elks, stags, aurochs, bears, wild boars, foxes, beavers, tortoises, several birds, and other animals still undetermined. An atlas and jaw, however, sent by M. Trogon to Prof. Pictet, of Geneva, were ascertained by this emi-

nent palæontologist to belong to *Cervus euryceros.* The length of the atlas is 0·265 metre, and its breadth 0·088 metre; both differing only by $\frac{1}{1000}$ from the measurements stated by Cuvier.

6. *Former Connection of Australia, New Guinea and the Aru Islands.* —Mr. A. R. Wallace in a paper on the Aru Islands, a group 150 miles South of Western New Guinea (Ann. and Mag. Nat. Hist., xx, Jan. 1858, p. 473), shows that the zoology of the Islands is closely related to that of New Guinea and Australia; and that shallow seas not only connect the two last, as others had before stated, but that they extend and include the Aru group. The depth of water over the whole to Australia is very nearly uniform at about thirty to forty fathoms. Mr. Wallace says:—

"But there is another circumstance still more strongly proving this connexion: the great island of Aru, 80 miles in length from north to south, is traversed by three winding channels of such uniform width and depth, though passing through an irregular, undulating, rocky country, that they seem portions of true rivers, though now occupied by salt water, and open at each end to the entrance of the tides. The phenomenon is unique, and we can account for their formation in no other way than by supposing them to have been once true rivers, having their source in the mountains of New Guinea, and reduced to their present condition by the subsidence of the intervening land."

Nearly one half of the Passerine birds of New Guinea hitherto described are contained in the author's collections made in Aru, and a number also of species in the other tribes.

The author farther observes on the absence of the peculiar East Indian types. "In the Peninsula of Malacca, Sumatra, Java, Borneo and the Philippine Islands, the following families are abundant in species and in individuals. They are everywhere *common birds.* They are the *Buceridæ*, *Picidæ*, *Bucconidæ*, *Trogonidæ*, *Meropidæ*, and *Eurylaimidæ;* but not one species of all these families is found in Aru, nor, with two doubtful exceptions, in New Guinea. The whole are also absent from Australia. To complete our view of the subject, it is necessary also to consider the Mammalia, which present peculiarities and deficiencies even yet more striking. Not one species found in the great islands westward inhabits Aru or New Guinea. With the exception only of pigs and bats, not a genus, not a family, not even an order of mammals is found in common. No Quadrumana, no Sciuridæ, no Carnivora, Rodentia, or Ungulata inhabit these depopulated forests. With the two exceptions above mentioned, all the mammalia are *Marsupials;* while in the great western islands there is not a single marsupial! A kangaroo inhabits Aru (and several New Guinea), and this, with three or four species of *Cuscus*, two or three little rat-like marsupials, a wild pig and several bats, are all the mammalia I have been able either to obtain or hear of."

7. *Earthquake in Italy*, (Athen., No. 1577.)—The phenomena which preceded and have followed the disastrous earthquake which has struck such a panic throughout this kingdom, have a remarkable and a separate interest from that of the afflicting details of the suffering occasioned by it, as many things occurred to show that before the event there was great subterranean agitation going on. Similar indications of existing agitation now continually manifest themselves. That Vesuvius has been in a

ɪtate of chronic eruption for nearly two years, and the wells at Resina 'or the last few months nearly dried up, I have already noted; that the kingdom has been in this interval, in various parts, alarmed by minor ɪhocks of earthquake, may not be so generally known, but such is the 'act, and to those signs of impending danger the Official Journal of the 30th of December adds the following: "The Syndic of Salandro (one of :he Communes which has suffered much from the recent scourge) reports :hat for nearly a month at about two miles distance from the town a gas has been observed to issue from a water-course; the temperature of it was about that of the sun. A few days since, too, from another similar 'osse, the same kind of gas issued. These exhalations were observed ɔnly in the morning, however; during the rest of the day they were not ɔerceptible. On the 22d of December, they ceased altogether, and there was an expectation that hot mineral springs would burst forth from that ɪpot." The Official Journal of the 2d of January relates another remark-ɪble fact. In the territory of Bella, about two miles from the town, the ɜarthquake on the night of the 16th of December levelled the neighboring ɪills, rolled the earth over and over, and formed deep valleys. Half an hour ɔefore the shock, a light as bright as that of the moon was seen to hover ɔver the whole country, and a fetid exhalation like sulphur was perceived. On the morning following the shocks, which were accompanied by loud ·umblings, a large piece of land, full 600 moggia (a *moggia* is something ess than an acre), and at about the same distance from the town, was 'ound encircled by a trench of from ten to twenty palms in depth, and he same in width. A letter from Vallo, now lying before me, and writ-en much in detail, speaks of "those two terrible shocks," and of the in-ıumerable minor shocks which have continued from the 16th of Decem-ɔer up to the present time—the letter being written on the 29th of De-·ember. "A few minutes before the first shock," adds the writer, "a ıissing sound was heard in the river, as if vast masses of stones were ɪeing brought down by a torrent. It is to be noted, too, that all the logs in the neighborhood howled immediately before the first awful hock."

Let us visit some of the ruined places at the centre of the disaster;—nd I will speak in the words of a gentleman who has just returned: "I ound the country seamed with fissures, which had at first been wide, but vhich gradually closed. The ground was heaving during the whole time f my visit to Polla. Once a beautifully situated township, with 7,000 ouls, it is now half in ruins, and the survivors were sitting or walking bout, telling us of their misery, and lamenting more that there were no ands to take out the dead or rescue the living. Two country people vere groping amongst the stones of a building; one found a body, and ırowing a stone towards the face called the attention of the other, 'That erhaps is some relation of yours,' but the body was not recognized. I ·ied to get food at a *trattoria*, the only house standing, at the corner of street; but the proprietor, who was by our side, repulsed me, and re-ısed to go in, saying that the moon has just entered the quarter, and we ıould have another earthquake. In most of these places, as in Naples, ıe deep, heavy rumblings which preceded and accompanied the earth-ıake have been much dwelt upon." On the night of the 26th of De-

cember, the little town of Sasso, near Castelabbate, consisting of one long street, was separated in two by the sudden opening of a fissure through its entire length, each side remaining separated from the other by a considerable interval—and so it stands. On the 28th and 29th of December, both in Sala and Potenza, strong shocks were felt, followed by many others of a less intense character, and these still continue. The consequences will be that even those houses which were only cracked will give way, and those which were feeble will be reduced to ruins. In Naples, too, the shocks continue producing vibrations of the doors and windows; and in one instance, I have heard ringing of the bells. The common report is, that since the 16th of December we have had eighty-four shocks in the capital. It is not at all improbable if every vibration is counted as one, and if the great subterranean agitation, which is now going on, be taken into account. Every one looks really with anxiety to Vesuvius, and prays, not for curiosity only, for an eruption. The indications of so desirable a result seem to be on the increase. A person who resides at Resina says, that on the night of the 29th, from 10 P.M. to 5 A.M. of the 30th ult., the whole town was in a state of continued vibration. Every three minutes a sound was heard as of a person attempting to wrench the doors and windows out of their places, followed by a quiver. The next morning the mountain was observed to vomit forth much smoke and a cloud of ashes. Friends, too, who reside at Capo di Marte, near the city, speak of the deep thunders which they hear from the mountain in the stillness of the night. The same phenomena are observed at Torre del Greco. I must, also, advert to the manifest lowness of the sea, which seems to-day to have receded from the land. I noticed this fact in my last letter, and tried to explain it as consequent upon the neap tides: but the same thing continues; and unless it has been occasioned by the long continuation of a land wind, the conclusion is inevitable that there has been an upheaving of soil. It would be rash, however, to come speedily to so important a decision. How this state of things will terminate, it is impossible to say; but that some great change is pending, there is but too much reason for supposing.

Some English gentlemen who have just returned from the scene of disaster give the following interesting though harrowing details:—"Before arriving at Pertosa, we found the houses on either side of the road thrown to the ground; the landlord of a tavern now abandoned told us that he had the good fortune to escape with his wife, but that his child and servant had been both killed. He himself bore the marks of a heavy blow on his face. The population of this place was about 3,000, and 143 bodies only had been dug out on the 1st of January; whilst 200 more were known to be missing. The whole town was destroyed, with the exception of six houses, which were in a falling state. Between Pertosa and Polla the strength and caprice of the earthquake were made manifest in a remarkable way. Crossing a deep ravine, we found the road on the opposite side carried off 200 feet distant from its former position: the mountain above it had been cleft in two, revealing to a great depth the limestone caverns in the bowels of the earth. The ground was seamed with fissures; and we could put our arms into them up to the shoulders. Polla has a population of 7,000 persons:—1,000 had fallen

victims, of whom 567 had been dug up and buried; the work of disinterment was continuing slowly, but the stench here and elsewhere, from the bodies, was insufferable. Three shocks of an earthquake were felt on this day, January 1. The first was very early in the morning; the second about half-past 12. When we were standing on the ruins of a church, the ground began to heave under our feet and the subterranean thunders to roll. We immediately fled from the spot, but were nearly overwhelmed as the wall of a bell-tower fell close upon our heels, and a leaning house, in an inclining state, came down within twenty feet of us. The frightened people immediately formed a procession, and headed by the priests, bearing the crucifix and an image of the Madonna, lashed themselves with ropes as they walked. On leaving the town, we rested on the wall of a bridge just outside, where some priests begged us to rise, saying we were in danger, for the ground was continually trembling. Whilst sitting there, we felt the third shock, and required no other hint." At the last moment, I add, from official documents, that upwards of 30,000 are returned as dead, and 250,000 living in the open air.

8. *Grenelle Artesian well*, (Athen., No. 1577.)—The artesian well on the plain of Grenelle, at Paris, built in the years 1831 to 1841 by the engineer, M. Merlot, has become the finest ornament of the Place Breteuil. According to the plans of the architect, M. Joon, a cast-iron tower, of about 140 feet in height, has been erected on the stone basis, in the centre of which a winding staircase with three landing-places, each of which has its own fountain, leads to the platform of the graceful building. On the top one enjoys a beautiful view, and, under the three watery tents, produced by the three *jets d'eau* of the well, the coolest and most refreshing of shades.

9. *Chemische und Chemisch-Technische Untersuchung der Steinkohlen Sachsens;* von W. Stein, Prof. der Chemie an der Königl. Polytechn. Schule zu Dresden. 98 pp., 4to. Leipzig, 1857.—This memoir contains the results of an extended research into the composition, and the economical value for fuel and lighting of the coal of the Saxon coal-beds. The following are a few of the results of the analyses:

Culm coal,	Ash	Carb.	Hyd.	Nit.	Ox.	Sulph.	
1. Berthelsdorf,	28·571	55·984	3·878	0·233	11·334	2·269.	G.=1·217
Zwickau coal,							
2. Zwickau,	2·640	77·211	5·149	0·242	13·321	1·789.	G.=1·294
3. "	4·950	81·410	5·222	0·845	5·735	2·955.	G.=1·192
Plauen coal.							
4. Hänichen,	12·607	71·258	3·882	0·493	11·478	1·149.	G.=1·358
5. Potschappel,	14·521	66·696	3·481	0·225	15·046	0·796.	G.=1·340

Volatile products of distillation in 2, 32·518; in 3, 37·333; in 4, 28·690; in 5, 21·531.

10. *Tooth of the American Elephant.*—Remains of the American extinct Elephant (or Mammoth) occur 60 miles north of the City of Mexico. One fine tooth in our possession, received from Mr. E. L. Plumb, comes from the Barranca of Regla, near Real del Monte in that region. Others are found in beds which are overlaid by lava.—Eds.

11. *Second Report on the Geological Survey of Kentucky*, made during the years 1856 and 1857; by David Dale Owen, Principal Geologist, assisted by Robert Peter, Chemical Assistant, Sidney S. Lyon,

Topographical Assistant. 392 pages, large 8vo.—The geological survey of Kentucky, as this second report evinces, is carried forward with energy and ability, and with important results to the State. The general report by Dr. Owen, takes up first Agricultural Geology, under which after a chapter of general remarks on soils, he treats of Kentucky soils; next chemical economic geology, comprising coals, iron ores, limestones, mineral springs and well waters; next stratigraphical geology.

The Falls of the Ohio are a noted locality for fossil corals. The following is given as a section of the rocks at that place, commencing above with the Devonian black slate, a well known horizon in the west.

1. Black bituminous slate or shale.

2. Upper crinoidal, shell, and coralline limestones, consisting of
   - *a.* White or yellowish-white earthy fractured layers, containing vast numbers of *Crinoids* (*Actinocrinus abnormis*, most common), a *Favosite*, a large *Leptæna*, and *Atrypa prisca.*
   - *b.* Middle layers; containing a few *Cystiphylla.*
   - *c.* Lower layers; containing many *Cystiphylla*, a *Syringopora*, and on Corn Island, remains of fishes, hence called the Upper Fish bed.

3. Hydraulic limestone, an earthy magnesian limestone; contains *Atrypa prisca*, a *Spirifer*, &c. Thickness 21 feet and less.

4. Lower crinoidal, shell, and coralline limestones; consisting in a great measure of comminuted remains of Crinoids, and containing *Spirifer cultrijugatus*, *Atrypa prisca*, a *Leptæna* near *euglypha*, and remains of fishes. Thickness 3 to 11 feet.

5. Olivanites bed; thickness 6 inches near the mill on the south side of the Ohio, 6 to 7 feet on Fourteen-Mile Creek.

6. A cherty band, charged with *Spirifer gregaria*, and many small hemispherical masses of *Favosites spongites*, thickness 1 foot; next below, a layer containing *Conocardium subtrigonale*, with large hemispherical masses of *Stromatopora* and a *Ceriopora?* 3 to 5 feet thick; next, the Lower Fish Beds, a limestone stratum 19 feet thick, containing a large and beautiful species of undescribed *Turbo*, a large *Murchisonia*, a *Conocardium*, *Spirifer gregaria*, a *Leptæna* and some small *Cyathophyllidæ.* The Conocardium layer is light gray; the Leptæna layer is two feet above it. The Fish remains are mostly about three feet above the Turbo bed, but are also distributed in other parts of the stratum.

7. Main beds of coral limestones: consisting of
   - *a.* Dark grey bed, containing hemispherical masses of *Favosites maxima* of Troost, *Zaphrentis gigantea*, immense masses of *Favosites basaltica*, sometimes as white as milk, *Favosites polymorpha.*
   - *b.* Black coralline layers, being almost a complete mass of fossilized corals, including *Cystiphylla*, *Favosites cornigera*, *Zaphrentis gigantea*, *Syringopora*, etc.

These Devonian beds rest upon an Upper Silurian stratum containing the Chain Coral (Catenipora).

Other sections are given and much important detail.

The chemical report of Dr. Robert Peter, exhibits a large and almost incredible amount of research. 206 analyses are reported, 7 of iron ores, 43 of soils, 31 of limestones, 30 of coals, 16 of mineral waters and salts, and others of rocks and ores. In the analyses of coals, the author has

not only ascertained the proportions of moisture, volatile matter, ashes and coke, but also the chemical composition of the ashes, the proportion of sulphur, and the relative proportions of carbon, hydrogen, oxygen and nitrogen.

The *Breckenridge cannel coal* afforded by *proximate* analysis (p. 211):

Moisture 1·80, volatile combustible matters 54·40, carbon in the coke 32·00, ashes 12·30 = 100.

Examining other specimens, the volatile matters varied from 55·70 to 71·70 per cent, the coke from 28·30 to 44·30, the ashes from 7·0 to 12·30 per cent, in the undried coal. The ashes contained

Silica 3·49, alumina and oxyd of iron 7·78, lime 0·55, magnesia 0·39 = 12·21.

By *ultimate* analysis it afforded

Carbon 68·128, hydrogen 6·489, sulphur 2·476, nitrogen 2·274, oxygen and loss 5·833, ashes 14·800 = 100.

Excluding the ashes and sulphur, the Breckenridge coal and the Boghead of Scotland compare as follows:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.
Breckenridge,	82·355	7·844	2·749	7·051
Boghead,	80·487	11·235	0·874	6·726

The Breckenridge coal is already noted for the mineral oils obtained from it by distillation. It affords per 100 lbs. 32 lbs. of crude oil. About 6000 gallons of crude oil are distilled at the company's works near Cloverport per week, and manufactured by distillation and purification into benzole, naphtha, illuminating and lubricating oils, and paraffine.

Haddock's cannel coal (Owsley County) is also a coal yielding a large amount of oil, it giving 55 to 60 gallons of crude oil (or 27 to 30 purified), to the ton of coal. In the following table different Kentucky coals are compared as to their yield of oils, from 1000 grains each.

	Crude oils.	Ammoniacal water.	Coke.	Gas (cub. in.)
Breckenridge cannel,	318·20	52·10	455	445
Haddock's cannel,	248·50	54·50	589	370
Union company's coal, bottom part,	148	38	750	465
Mulford's five-foot, or main coal,	136·50	64·75	684	567
Robert's, or Muddy river coal,	102·10	119·80	659.50	370
Ice House coal,	108	73	714	465
Youghiogheny coal,	136	52	710	545.

The topographical report of Mr. Lyon contains an account of observations upon the Eastern and Western Coal Fields, tracing out the beds of coal, and the features of the country, and illustrating the subject by many sections. Near Owingsville in Bath county (eastern part of the State), a section extending from the Lower Silurian (Blue limestone) to the beds at the base of the coal measures in Carter Co., showed a total thickness of 2,520 feet; of this 100 were the soft beds of the coal measures; 75 to 100 millstone grit (but thinning out to 14 feet on the Ohio near the mouth of Tigert's creek); 100 feet muddy shale with thin beds of limestone; 350 feet subcarboniferous limestone (thinning out to 12 feet on the Ohio); 20 to 75 feet of grindstone grit; 725 Waverley sandstone of Ohio; 120 black Devonian shale; 700 buff porous limestone of Lewis, Fleming and Bath Cos.; 75 limestone producing red earth by disintegration; 100 slaty mudstone, thin-bedded; 150 Lower Silurian, containing

Leptæna alternata, Orthis occidentalis, Orthis (Spirifer) Lyra, and also *Murchisonia bicincta?*

This volume is to be soon followed by another giving the remainder of the Report.

12. *New species of Fossil Plants from the Anthracite and Bituminous coal-fields of Pennsylvania;* collected and described by LEO LESQUEREUX, with Introductory observations, by H. D. ROGERS, (Jour. Bost. Soc. Nat. Hist., vi, No. iv, 409).—This memoir contains descriptions of 106 new species of coal-plants from the coal-fields of Pennsylvania. Prof. Rogers, in his introductory observations, states that M. Lesquereux has found that out of over 200 species examined by him, 100 are "identical with species already recognized in the European coal-fields, and some 50 more of them show differences so slight that a fuller comparison with better specimens may result in their identification likewise;" moreover "those new species which seem to be restricted to this continent are every one of them in close relationship with European forms." The new species are of Calamites 2, Asterophyllites 5, Annularia 1, Sphenophyllum 2, Nœggerathia 3, Cyclopteris 5, Neuropteris 13, Odontopteris 2, Sphenopteris 8, Hymenophyllites 3, Pachyphyllum (new genus) 5, Asplenites 1, Alethopteris 5, Callipteris 1, Pecopteris 7, Crematopteris 1, Scolopendrites 1, Caulopteris 2, Stigmaria 5, Sigillaria 9, Lepidodendron 10, Lepidophyllum 6, Brachyphyllum 1, Cardiocarpon 3, Trigonocarpum 1, Rhabdocarpus 1, Carpolithes 3; and Pinnularia 5 (named but undescribed).

The new genus *Pachyphyllum* is thus described. Frond large, thick, membranaceous, broadly oval or lanceolate in outline, either pinnately or irregularly lobed; radical or borne on a thick rachis? divisions short, lanceolate, obtuse, or long linear-flexuous; nerves thick, compound and parallel near the base, separating above and solitary in each division or disappearing totally. The *Schizopteris Lactuca* of Sternberg is referred to this genus.

13. *Illinois Geological Survey. Abstract of a Report on Illinois Coals, with Descriptions and Analyses, and a General Notice of the Coal-fields;* by J. G. NORWOOD, M.D. 94 pp., 8vo. Chicago, 1858. Published by order of the Governor.—Fifty-eight pages of this Report are occupied with analyses of coals from different beds in Illinois, with brief notices of the localities. The few points noticed in the analyses are loss in coking, total weight of coke, moisture, volatile matters, carbon in coke, ashes, carbon in the coal, with the specific gravity. The specific gravities vary between 1·21 and 1·3, excluding a few very impure; and the volatile matters between 30 and 44 per cent; the ash mostly 5 to 8 per cent.

The Report contains a small colored geological map of the State, giving the general outlines of the coal-fields and of the formations on its borders. The author remarks on the fact, that the coal-field is not a continuous one, but throughout its extent is broken into patches by uplifts of the millstone grit and carboniferous limestone; the displacements having been so great as to produce tiltings at all angles up to vertical. He states that the lower coal-beds were deposited in basins thus formed; that there was then a farther displacement and erosions, and these new valleys and basins were filled with new deposits of coal, and so on up to the termination of the carboniferous epoch. We regret that the Report

is geologically so meagre, as a few facts and sections proving the exact age of these uplifts would be of great interest. The details are promised in the full Geological Report.

These uplifts were alluded to at the Albany meeting of the American Association by Mr. Worthen, who stated that the strike of them was northwesterly, and therefore parallel to the Rocky mountain range.

14. *Denkschriften der Kaiserlichen Akademie der Wissenschaften Mathematisch-naturwissenschaftliche Classe.* Vols. 11 and 12. 1856.—The volumes of Transactions of the Vienna Royal Academy are not exceeded by any others in the world in typography, beauty of illustration, or the value of the science they contain. In Geology, the contents of the *eleventh* and *twelfth* volumes are as follows:—

On the Cephalopods of the Lias of the northeast Alps, by F. R. v. Hauer, 86 pp. 4to, with 25 plates (of Ammonites and all highly beautiful).

On the Palæontology of the Thuringian Forest, by R. Richter and Fr. Unger. 100 pp., 16 plates.

On the Fossil Fishes of Austria, by J. J. Heckel. 88 pages, with 15 plates.

On the Gasteropoda of the Trias of the Alps, by Dr. M. Hörnes, with 3 plates.

On Foraminifera of the Family Stichostegues of D'Orbigny, by J. L. Neugeboren, with 5 plates.

There are also other papers,—by Dr. K. M. Diesing on the Acanthocephala and Cephalocotylea (Intestinal worms) with many fine plates; Prof. J. Hyrtl on the Anatomical structure of the Mormyrus and Gymnarchus; K. Kreil on Magnetic observations at Vienna; K. Langer on the circulating system in the Anodonta; J. Grailich on the refraction and reflection of light by twin faces; Ignaz Heger, Auflösungsmethode für Algebraische Buchstabengleichungen mit einer einzigen unabhängigen Buchstabengrösse.

15. *On the part which the Silicates of the Alkalies may play in the Metamorphism of Rocks;* by T. Sterry Hunt, Esq., of the Geological Survey of Canada, (Proc. Roy. Soc., in L. E. and D. Phil. Mag., xv, 68.) —In my last communication to the Royal Society on the Metamorphic Silurian Strata of Canada, I endeavored to show, from the results of analyses of the altered and unaltered rocks, that it is the reaction between the siliceous matters and the carbonates of lime, magnesia, and iron of the sedimentary deposits, which has given rise to the serpentines, talcs, pyroxenites, chlorites, and garnet rocks of the formation. I then cited the observation of Bischof that silica, even in the form of pulverized quartz, slowly decomposes these carbonates at a temperature of 212° F., with evolution of carbonic acid; the same author mentions that a solution of carbonate of soda has the power of dissolving quartz under similar conditions.* Desiring to verify these observations, I have since made the following experiments.

Colorless crystalline quartz was ignited, finely pulverized, and then boiled for an hour with a solution of its weight of perfectly pure carbonate of soda; the amount of silica thus dissolved was 1·5 per cent of the

* Bischof's Chem. and Phys. Geology, Eng. Edition, vol. i, p. 7.

quartz, but on repeating the treatment of the same quartz with a second portion of the carbonate, only ·35 per cent was dissolved. The object of this process was to remove any soluble silica, and the quartz thus purified was employed for the following experiments, which were performed in a vessel of platinum.

I. 1000 parts of quartz and 200 of carbonate of soda were boiled with water for ten hours, and the mixture was several times evaporated to dryness, and exposed for a few minutes to a temperature of about 300° F. The amount of silica taken into solution was 12 parts.

II. A hydrocarbonate of magnesia was prepared by mingling boiling solutions of sulphate of magnesia and carbonate of potash, the latter in excess; the precipitate was washed by boiling with successive portions of water. 1000 parts of quartz were mixed with about as much of this magnesian carbonate and boiled as above for ten hours. An excess of hydrochloric acid was then added, the whole evaporated to dryness, and the magnesian salt washed out with dilute acid. The residue was then boiled for a few minutes with carbonate of soda, and gave 33 parts of soluble silica.

III. A mixture of 1000 parts of quartz, 200 of carbonate of soda with water, and an excess of carbonate of magnesia was boiled for ten hours, and the residue, treated as in the last experiment, gave 148 parts of soluble silica. The alkaline liquid contained a little magnesia, but no silica in solution. That the soluble silica was really combined with magnesia was shown by boiling the insoluble mixture with sal-ammoniac, which, dissolving the carbonate, left a large amount of magnesia with the silica. This silicate was readily decomposed by hydrochloric acid, the greater part of the silica separating in a pulverulent form.

The third experiment was suggested by some observations on the reactions of silicate of soda with earthy carbonates. Kuhlmann has remarked the power of carbonate of lime to abstract the silica from a boiling solution of soluble glass,* and it is known that alumina exerts a similar action. I have found that when artificial carbonate of magnesia in excess is boiled with a solution of silicate of soda, the latter is completely decomposed with the formation of carbonate of soda, and a silicate of magnesia which gelatinizes with acids; and I have long since described this reaction in the evaporation of alkaline mineral waters.† This mutual decomposition of carbonate of magnesia and silicate of soda, conjoined with the power of carbonate of soda to dissolve silica, leads to a curious result. If we boil for some hours a mixture of ignited silica, obtained from the decomposition of a silicate by an acid (and consequently readily soluble in all alkaline carbonates), with a small portion of carbonate of soda and an excess of hydrocarbonate of magnesia, we obtain a dense powder which contains all the silica united with magnesia, and may be boiled with carbonate of soda and sal-ammoniac without decomposition. It is obvious from the above experiments that similar results may be obtained with quartz, although the process is much slower; it would doubtless be accelerated under pressure at a somewhat elevated temperature, which would enhance the solvent power of the alkaline carbonate.

* Comptes Rendus de l'Acad. des Sciences, Dec. 3rd and Dec. 10th, 1855, where will be found many important observations on the alkaline silicates.

† Reports of the Geol. Survey of Canada, 1851-53-54.

Silicates of potash and soda are everywhere present in sedimentary rocks, where decomposing feldspathic materials are seldom wanting, and these salts in the presence of a mixture of quartz and earthy carbonates, aided by a gentle heat, will serve to effect a union of the quartz with the earthy bases, eliminating carbonic acid. A small amount of alkali may thus, like a leaven, continue its operation indefinitely and change the character of a great mass of sedimentary rock. Such a process is not only a possible but a necessary result under the circumstances supposed, and we cannot, I think, doubt that alkaline silicates play a very important part in the metamorphism of sedimentary rocks, which are composed for the most part of earthy carbonates, with siliceous, aluminous, and feldspathic materials.*

The direct action between the carbonates and silica must necessarily be limited by their mutual insolubility, and by the protecting influence of the first-formed portions of earthy silicate; but with the solvent action of a small portion of alkali, which is changed from silicate to carbonate, and then back again to silicate, the only limit to the process would be the satisfying of the mutual affinities of the silica and the basic oxyds present.

16. *On the Extinct Volcanoes of Victoria, Australia;* by R. BROUGH SMYTH, Esq., C.E., F.G.S., (Proc. Geol. Soc., in L. E. and D. Phil. Mag., xv. p. 74.)—The district in Southern Australia in which lavas, basalts, and other evidences of recent igneous action are found, extends from the River Plenty (a tributary of the Yarra), on the east, to Mount Gambier on the west. Its most northern point is Macneil's Creek (a tributary of the Loddon), in 37° S. lat., and its most southern point is Belfast, in 38° 21′ S. lat. Its extreme length is 250 miles, and its extreme breadth about 90 miles.

The following were enumerated and described as the most distinctly marked crateriform volcanic hills:—

1. A hill near the source of the Merri Creek, on the Dividing Range, about 25 miles north of Melbourne, and already described by Mr. Selwyn, the Government Geologist. 2. Mount Atkin, about 1500 feet above the sea-level. 3. Mount Boninyong, adjacent to the Ballarat Gold-fields. 4. Larnebaramul or Mount Franklyn. 5. Mount Rouse. 6. Several crateriform hills around Lake Koraugamite, and the often conical hills known as the Stony Rises. 7. Tower Hill, between the towns of Warnambool and Belfast, and close to the coast. In the last-mentioned instance the scoria has been found by well-sinkers to overlie, at the depth of sixty-three feet, the original surface of the ground, covered with coarse grass, such as that now found growing, and amongst this dry, but not scorched, grass the workmen are said to have found some living frogs.

Over nearly the whole extent of Victoria there are masses of intrusive basalt, in some places columnar, breaking through both the granite and the palæozoic strata, and occasionally through the overlying Tertiary (Miocene) beds also. Extensive denudation has destroyed the probably overlying portions of these old basaltic outbursts, both before and after

* It is well known that small portions of alkalies are seldom or never wanting in the earthy silicates, such as serpentine, talc, pyroxene, asbestus, epidote, idocrase, and even beryl and corundum. See the memoir of Kuhlmann already cited.

the tertiary period. A newer series of eruptive trap-rocks, sometimes as dense and hard as the older basalts, but more frequently vesicular and amygdaloidal, pierce the old tertiary and also the post-tertiary beds, or the later quartzose and auriferous drifts. These newer basalts and lavas were probably erupted at a period when considerable areas, both north and south of the main-coast range, were submerged; and the lavas cooled rapidly and not under very great pressure. These eruptions do not appear to have disturbed the Tertiary beds, which are usually found nearly horizontal. After these newer basaltic lavas were erupted and denuded, and after the deposition of the overlying pleistocene drift, some of the volcanoes were still acting, though not so energetic as previously, emitting porous lavas and pumice; and at a still later period, volcanic ash and scoria, such as that which rests on the ancient humus at Tower Hill, and that of Mount Leura and the Koraugamite district, were thrown out when the igneous force was almost exhausted. Mr. R. B. Smyth pointed out the interest attached to the extinct volcanos of Victoria as connected with the great volcanic chain extending from the Aleutian Islands to New Zealand; and concluded with some observations on the recent occurrence of earthquake-movements in Southern Australia, and on the coast-line, as having reference to the probably not yet exhausted force of the volcanic foci of that region.

17. *On the occurrence of Marine Animal Forms in Fresh-water.*—A translation of a paper by Dr. E. von Martens, on this subject, is published in the Annals and Magazine of Natural History, [3], i, 50. The facts are important in their bearing on the determination of the marine or freshwater character of geological formations from their fossils.

18. *Wollaston Medal.*—The Geological Society of London at the anniversary meeting, Feb. 25, 1857, awarded the Wollaston medal to M. Barrande, the distinguished palæontologist, and the balance of the proceeds of the Wollaston Donation Fund to Mr. S. P. Woodward, author of the excellent "Manual of the Mollusca," and now engaged on a "Manual of the Radiated Animals."

III. BOTANY AND ZOOLOGY.

1. *DeCandolle's Prodromus*, Part II of Vol. XIV (pp. 493—706) was published near the close of the past year. It contains the *Thymelæaceæ* by Meisner, the *Elæagnaceæ* by von Schlechtendal, the *Grubbiaceæ* by DeCandolle, resting merely on one of those outlying or anomalous genera which there is too great tendency to raise to ordinal importance, merely because the author knows not what to do with them,—and *Santalaceæ* by DeCandolle. Of the first order we have only *Dirca*, peculiar to this country, and with no congener known. There is nothing to add respecting our three species of *Elæagnaceæ*. As to our few *Santalaceæ*, it is interesting to remark that one of our characteristic genera, *Pyrularia* (the Oil-nut), is found to have two representatives in the Himalayas (*Sphærocarya*, Wall.), and apparently two more in southern India (*Scleropyrum*, Arn.). Also that an European species is introduced into our *Comandra* (the *Thesium elegans* of Rochel), and the genus itself shown to be hardly distinct from *Thesium*. And *Darbya*, Gray, published in this Journal twelve years ago, is reduced to a subgenus of *Comandra*,—to which we

are not disposed to object. But we take the new species of true *Comandra*, *C. pallida*, to be a mere variety of *C. umbellata*; which, by the way, we did not state to be eight or ten *feet*, but only as many *inches* in height. DeCandolle thinks that the hairs which connect the anthers of *Comandra*, and of most *Thesia* also, with the perianth, belong to the latter, not to the former, as the generic name implies. Our own observations, and especially some made by Mr. H. J. Clark upon very young flower-buds, confirm this view. The discovery, announced in this Journal in 1854, that the striking genus *Buckleya*, Torr., is truly dichlamydeous in the female flowers, proves a capital fact for M. DeCandolle; who draws from it the confident inference that the floral envelop which in all other plants of the order occurs alone, and has the stamens opposite its lobes, is *corolla* and not calyx, and consequently so in the *Loranthaceæ* and *Proteaceæ* also. Our author's views are presented in detail in an article, *Sur la Famille des Santalaceæ*, in the *Bibliothèque Universelle*, published last autumn, and they appear well-nigh convincing. An analogous case is found in *Zanthoxylum* (only here the suppression is the rare case), *Z. Americanum* plainly wanting that which in *Z. Carolinianum* is the corolla (*Genera Illustr.* 2, p. 148). *Nyssa* offers a good instance of the limb of a calyx so reduced as to have escaped notice, until four years ago. For what to DeCandolle seem to be petals (p. 622, note in char. of order *Santalaceæ*), were *seen* to be so, and the observations recorded in the 5th volume of the *Memoirs of the American Academy*, p. 336, and afterwards extended in the *Manual Bot. U. S.*, ed. 2, p. 162 (1856). It is singular that DeCandolle should remain so uncertain of the place of *Nyssa* in the Natural System. If he will compare it and *Mastixia* with *Cornus* he will surely be convinced that *Nyssa* is a true Cornaceous genus. So of *Cevallia*, the true place of which our author seems not to know, although given in the *Flora of North America* many years ago, under the sanction (we may add) of the very highest authority. Indeed, so plain is its relationship to *Gronovia* that Fenzl soon saw and corrected his mistake in referring the genus to *Calycereæ*. And if at this day any should doubt that these are Loasaceous plants, let them turn to the characters of *Petalonyx*, in *Mem. Amer. Acad.*, 5, p. 319.

Leaving these details, let us consider our pleasing prospect in respect to the continuation (at least through the *Dicotyledoneæ*) of the great work upon which the DeCandolles, father and son, and other excellent botanists, have bestowed so much labor and talent. The great order of *Lauraceæ* was to have been included in the present volume. It would have extended the volume unduly. But, unfortunately, or fortunately, as the case may be, Professor DeVriese has gone to Java on a government mission without finishing the work; and the indefatigable Meisner now takes it in hand. It is to form the leading part of volume 15, the *Begoniaceæ* by DeCandolle himself, and the *Aristolochiaceæ* by Duchartre being appended, and perhaps the *Euphorbiaceæ*, also by DeCandolle, except the genus *Euphorbia* which Boissier undertakes. The 16th volume is intended to commence with the *Urticaceæ* proper, by Weddell, or the *Monimiaceæ* by Tulasne. We are pleased to learn that Prof. Andersson of Stockholm is to elaborate the *Salicineæ*; and we beg of all North American botanists that they will collect for him all the native Willows

and Poplars of their districts, taking pains to procure blossoms, foliage, and fruit from the same trees. And for DeCandolle himself, who will probably undertake the *Cupuliferæ*, we likewise ask for good and copious specimens of every species or form of our American Oaks. Specimens communicated to the writer of this article will be duly forwarded, and will doubtless be very useful. Such arrangements are made as to render it probable that the *Dicotyledoneæ* may be completed in the Prodromus in the course of three or four years. A. G.

2. *Dr. Hooker's Flora of Tasmania* has been issued as far as to Part V, which completes the first volume, and the Dicotyledonous class, *Coniferæ* included: 359 pages, and 100 admirable plates. The work is published by Lovell Reeve, London, in the same form and style as the *Flora Antarctica* and the *Flora of New Zealand*. It is enough to say that the work is of the very highest character, and that it abounds with important observations upon the structure and affinities of plants. One volume more will finish this series of high southern Floras, which—although they embrace only a part of the author's botanical writings—would appear sufficient to represent a life-time of arduous scientific labors. A. G.

3. *Journal of the Proceedings of the Linnæan Society* (Botany); No. 6, 1857.—Dr. Thomson's interesting paper upon the embryo and germination of *Barringtonia* and *Careya* is concluded. The embryo is shown to be exalbuminous, essentially a macropodous radicle, destitute of cotyledons, developing from one end a nearly naked plumule, and from the other a primordial slender root. Drs. Hooker and Thompson continue, in a second series, their *Præcursores ad Floram Indicam*. They here take up a group of related orders, consisting of "*Saxifrageæ* (including *Hydrangeæ*, &c.), *Crassulaceæ*, *Droseraceæ*, *Parnassieæ*, *Grossularieæ*, *Hamamelideæ*, and *Philadelpheæ*. The very close relationship of the group or alliance to *Rosaceæ* on the one hand and to *Cornaceæ* on the other is pointed out. The resemblance of *Parnassia* to *Saxifraga*, as indicated by Brown, is insisted on, and the affinity strengthened by the discovery that the stamens advance in pairs to the stigma, as in the latter genus, and by the disposition to an adhesion of the calyx-tube with the base of the ovary, which (somewhat evident even in our *P. Caroliniana*) is very striking in several species. We are pleased to find, however, that Dr. Hooker retains *Parnassia* as a distinct order, on account of the 'staminodia' and the exalbuminous seeds. But he omits all mention of the anomalous position of the stigmas, which is decidedly anti-saxifrageous, as also is the division of the styles or stigmas in *Droseraceæ*. (There is an oversight or misprint on p. 78, in speaking of the *parietal* placentation of *Elodea*.) The transference of *Droseraceæ* to the Saxifragal alliance *en suite* to *Parnassieæ*, is surely a happy thought, naturally suggested by our author's discovery of the perigynous character of some Antarctic species, and by the other obvious points of resemblance with *Parnassia*. But we demur to the statement that "*Droseraceæ* and *Grossularieæ* seem to be rather aberrant members of *Saxifrageæ* in its extended significance, than separate orders." But, if there be here "too much easiness in admitting variations" of the order, there is on the other hand, as it seems to us, "too much stiffness in refusing" to admit the *Philadelphieæ*, which, as our authors limit the groups, are distinguishable from *Saxifragaceæ* by

no one assignable character. If limited to *Philadelphus* and to *Carpenteria* (which is as it were a *Philadelphus* with an almost free ovary) the group may indeed be distinguished by the convolute æstivation of the petals; but this is of no great moment in such a case, especially since *Jamesia* exhibits a transition into the ordinary imbricative mode. (See Bot. U. S. Expl. Exped., 1, p. 663, note.) In *Pileostegia* our authors bring to our knowledge an interesting new Hydrangeous genus. They also have a new Crassulaceous genus, *Triactina*, a sort of *Sedum* with the carpels reduced to three and connate half way up. So that, with this genus, *Penthorum* and *Diamorpha*, on the one hand, and *Spiræanthemum* on the other, the interval between *Crassulaceæ* and *Saxifragaceæ*, so far as respects technical distinctions, is completely bridged over. A. G.

4. *Plantæ Indiæ Bataviæ Orientalis, quas .... exploravit* CASP. G. C. REINWARDT. Digessit et Illustravit GUIL. H. DE VRIESE. Leyden. Fasc. I, 1856. Fasc. II, 1857, pp. 160, tab. 1–8. Roy. 4to.—The venerable Reinwardt died in the year 1854, and his botanical collections, made in the Dutch East Indies about thirty years ago, were bequeated to the herbarium of the Leyden Botanic Garden; and their publication in very handsome style has been commenced by Professor De Vriese, aided by other able botanists. The first fasciculus comprises the *Gesneriaceæ*, *Ternstrœmiaceæ*, *Sapotaceæ*, *Myrtaceæ*, and *Dilleniaceæ* by De Vriese, and the *Hepaticæ* by Dr. Van der Sande La Coste. *Sauravja*, of which many species are here described, is taken as the type of a distinct order, but nothing new is suggested in respect to its affinities. We suspect that Planchon is right in considering it as of the Ericaceous type. Several species are said to have their styles united at the base, and a trigynous species is said to have them united up to the middle. This militates against *Draytonia*. The second fasciculus contains the *Araliaceæ* by Miquel, the *Myristicaceæ*, by De Vriese, the *Gramineæ* by L. H. Buse, the *Musci Frondosi* by La Coste, the *Urticaceæ* by Weddell, and the *Cyperaceæ*, *Aroideæ*, *Combretaceæ*, *Saxifragaceæ*, &c., and *Rubiaceæ* (commenced), by Miquel. Miquel's new Cunoniaceous genus *Spiræopsis* is much closer to *Weinmannia* than our *Spiræanthemum*. The plates of this work are truly beautiful. A. G.

5. *Botanical Necrology for* 1857.—*Charles Girou de Buzareingues* of the South of France.—*A. N. Desvaux*, who was a botanist of some consequence in the earlier part of the century, when he was the editor of a well known Botanical Journal. In 1817 he became director of the Botanical Garden of Angers where he remained until his death. His son *Emille Desvaux*, a very promising botanist, who elaborated the Grasses for the Flora Chilena, died a few years ago, at an early age.—*F. W. Wallroth*, a well known German botanist, the monographer of *Orobancheæ*.—*Targioni-Tozetti*, the distinguished Florentine botanist.—*W. G. Tilesius* (born in 1769), the naturalist of Krusenstern's voyage of exploration in 1803–1806!—*L. W. Dillwyn* (born in 1778), of Swansea, S. Wales.—*H. D. A. Ficinus*, of Dresden, author of a Flora of the neighborhood of Dresden and other works.—*M. Graves*, of Paris, a well known French botanist, but scarcely a botanical author.

To this list we may add the name of the venerable *Madame de Jussieu*, widow of *A. L. Jussieu*, and the mother of *Adrien*, who died in Paris

last year, at a very advanced age. The library and collections of this distinguished family are now dispersed. The herbaria we believe have gone to the *Jardin des Plantes*, but the library, so rich in botanical works, and especially in separate memoirs, gathered with such pains by at least three generations of botanists, is before this time widely dispersed by the hammer of the auctioneer.

An equally venerable name is now to be added, that of the distinguished algologist, *Mrs. Griffiths*, of Torquay, England, who died in the latter part of January, at the age of ninety. To her, almost half a century ago, Agardh dedicated the genus *Griffithsia*, a beautiful group of plants of the family she loved so well and so successfully cultivated even to the last, continuing her scientific correspondence with her friends down to the last months of her long and actively useful life.

We have also to announce the death, at the beginning of the present year, of *Dr. J. Forbes Royle* of London, author of Illustrations of the Botany of the Himalaya Mountains, and of various other works upon the botany, materia medica, and the industrial products of India. A. G.

6. *Notice of the occurrence of Green-gilled Oysters;* by W. J. Taylor.—A curious characteristic of the oysters of a locality in a sound on the eastern shore of Maryland may interest naturalists. The sound is on the Atlantic coast, and its principal outlet is Chincoteague Inlet. The oysters in question were taken from the latter named place where they had been planted to prepare them for the markets of New York and Philadelphia. They were planted about four years ago, at which time from some unknown cause numbers of them died. After a time they thrived greatly and were prized for their superior size and fine flavor.

After two years had elapsed, a peculiar green color was observed in the gills which continues; it is particularly intense and marked in the fall and winter when the mollusc is fat, and nearly disappears in the spring and summer. The color is only in the gills, the mantle being white; it may be termed a pea-green. By cooking it becomes darker; but it nearly disappears when the mollusc is placed in dilute alcohol.

The oysters are planted on a hard sandy bottom which has a slight coating of dark mud, in which grows a very small grass. The locality is within eight or nine miles of "Green Run" inlet, which is rapidly filling up with sand, which already prevents navigation. The tide ebbs and flows regularly about four inches. The same peculiar green color was noticed in oysters at this locality fourteen years ago, after which time it disappeared. The same color not so strongly marked has been observed near Chincoteague inlet.

7. *Humming Bird of the U. States*, (Ann. and Mag. Nat. Hist., [2], xx, 520).—Mr. Gould having returned from a visit to the United States, whither he had proceeded for the purpose of studying the habits and manners of the species of *Trochilus* frequenting that portion of the American continent, detailed some of the results of his observations.

Having arrived just prior to the period of the bird's migration from Mexico to the north, and having had ample opportunities for observing it in a state of nature, he noticed that its actions were very peculiar, and quite different from those of all other birds: the flight is performed with

a motion of the wings so rapid as to be almost imperceptible; indeed the muscular power of this little creature appears to be very great in every respect, as, independently of its rapid and sustained flight, it grasps the small twigs, flowers, &c., upon which it alights with great firmness, and if wounded clings to them with the utmost tenacity: it appears to be most active in the morning and evening, and to pass the middle of the day under the shade of the thick leafy branches. Occasionally it occurs in such numbers, that fifty or sixty may be seen on a single tree. When captured, it so speedily becomes tame, that it will feed from the hand or mouth within half an hour. Successful in keeping one alive during a long railway journey, in a gauze bag attached to his breast-button, for three days, during which it readily fed from a small bottle filled with a syrup of brown sugar and water, Mr. Gould determined to attempt the bringing of some living examples to England, in which he succeeded, but unhappily they did not long survive their arrival in London, and died on the second day: had they lived, it was his intention to have sent them to the Society's Gardens, where they would doubtless have been objects of great attraction. Mr. Gould added that he was certain that they might be readily brought to this country; that they would live in the gardens at least during the months of summer, and that the captains of any of the great steamers now voyaging between England and America would willingly render the assistance requisite to effect this desirable object.

8. *Leptosiagon*, Trask, nov. gen. (Proceedings of the California Academy of Natural Sciences, vol. i, p. 99, plate vi.)—Described by the author as a new genus of microscopic organisms referable to "the family of crustaceas, their form and inorganic structure, with their configuration seeming to warrant this, more properly perhaps than among the zoophytes or diatoms." They are said to be styliform, membrano-calcareous, with a central canal divided by transverse septa; the extremity armed with a moveable mandibular process. Eight species are described occupying "an extended geographical range, from Mexico to Japan." The figures of the plate are well executed; and to judge from them, these forms must have a remarkably close resemblance to the falcigerous setæ of some Annelides, *Nereis* for instance, both in form and structure. These setæ vary much in character in the different rings of the same worm, so that if our conjectures be true, all of these objects may belong to two or three species of Annelides. W. S.

IV. ASTRONOMY.

1. *Note on the Periodicity in the Sun's Spots;* by O. REICHENBACH, (Communicated by letter dated Norristown, Pa., Jan. 15, 1858).—The frequency of "spots" as observed mainly by Mr. Schwabe of Dessau, embraces, in passing from maximum to minimum, a period of about 11 years. The causes of phenomena are far and near; there is often idle discussion about two claims. In suggesting a cause, I shall not indulge in fanciful details on the processes at the sun's surface, on the effects rather than causes, which practical men, consulting experience alone, conjecture, but which theory framers, as I confess to be, believe themselves unable to observe.

The period is about 11 years, the number of our year giving an ill-defined mark. A period by a primary cause oscillates by secondary causes. The revolution of Jupiter, the largest planet, is 11·86 years. There is affinity in these numbers. The maxima occurred in 1828, 1837 and 1848; another draws near; farther off, six periods correspond to six revolutions of Jupiter; but I may be mistaken, and by a constant acceleration seven periods may take place. When we try to combine the days of observation, the number of spots and of spotless days, we find the increase and decrease to be in a slow ratio before and after the maximum, and the decrease and increase in a rapid ratio before and after the minimum, a coincidence with the requirements of elliptic motion.

In 1828, 1837 and 1848 occurred the maxima. In 1827, 1839, 1851, 1862, Jupiter passes its aphelion. The first numbers coincide. The frequency of spots corresponds to the aphelion of Jupiter. The pressure at the perihelion, as my theory supposes, expands and increases the envelop; the aphelion condenses it, introducing a rapid alternation of precipitation and evaporation; the mass is thereby allowed to descend and meet in the equatorial regions, and the temperature is there increased. The numbers do not all coincide. But

(1.) Do the maxima by groups of spots correspond to the greatest area and darkness? No days were spotless in 1829, 1838 and 1839, all those years produced spots of largest dimensions.

(2.) There is a number of other planets; if we abstract from the far and slow, and the near and rapid small ones, the second central planet remains as the principal disturber. In 1827, Saturn was 10° (corresponding to the aphelion of Jupiter) in advance of its perihelion, and the number of spots was considerably less than in 1837 or 1848. In 1839 Saturn was 23° from its aphelion, advancing toward it. During the preceding years both planets advanced together towards their aphelions, and the greatest number of spots occurred before 1839. The reason of this anticipated maximum becomes obvious when we consult the position of the two aphelions. When the two planets draw near each other, the attractive force of the greater diminishes the spot-producing power of the smaller, the combined pressure on the sun is increased, the average distance diminished, the angular velocity of the greater augmented, whereas both planets advance in 1837 towards their aphelions in the latter half of the semi-orbits, but differ still about a quadrant in length, their spot-producing effect culminates, they exercise the least pressure, the least repulsion on the *interior* sun. In 1851 Saturn was 60° from its perihelion advancing towards it; beyond 48° its effect diminishes, the spot-producing effect of Jupiter still advancing to its aphelion. In 1862 Saturn will be 82° from its perihelion (in 1857–58 the time of the two perihelions pretty near coincides) advancing to its aphelion, and the maximum will be delayed till near that time. There is here a coincidence with the aphelion of Jupiter, but the maximum is in itself small. The next period, 1874, is brought down to 1872.

A relation between the "spots" and the oscillations of magnetism is suspected; it must exist. The planets must influence the magnetism; the effect from Jupiter on the earth must be large, as the latter twelve times revolving, passes at one time between the sun and that planet in its

perihelion and then in its aphelion. The earth is now pressed, now elated, its envelop now expanded, now condensed, between those two rotating balls, or magnets, or voltaic piles, or weights, or whatsoever they are called with reference to phenomena classed under those various denominations.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Telestereoscope.*—Professor HELMHOLTZ has described an instrument (Pogg. Ann., 1857, and Phil. Mag., Jan. 1858) which he calls a *Telestereoscope* (Telescopic stereoscope), the object of which is "to present, stereoscopically united, two pictures of a landscape corresponding to two points of view, whose distances considerably exceed the distance between the two eyes." The stereoscopic power of the eyes is small, because the distance between them is small. By the instrument it is widened, and the effect which a stereoscope produces in a picture of a landscape is thrown over the landscape itself. The instrument is made up of four mirrors and two eye-glasses. Two mirrors placed, alike, at an angle of 45°, one to the right and the other to the left, receive the rays of light from the landscape. These mirrors throw the rays horizontally towards one another to two oblique mirrors, which throw the rays through the eye-glasses to the eyes. In a window, place on either side, say three or four feet or the width of the window apart, a mirror, at the angle stated, to receive the rays from outside, the planes of the two mirrors converging of course to a point in the room. The mirrors will have the position of the half-opened shutters of the window. The rays from the scene outside on reaching them will be thrown parallel to the window, those of one mirror towards the other. Now by placing at the middle of the window two smaller mirrors meeting like the legs of a V, but at an angle of 90°, and facing in the room, the rays will be thrown into the room; and if these two mirrors are not too large or are properly placed, the rays will have just the distance apart required to pass into the eyes. A box or frame may enclose the mirrors, and a couple of lenses be inserted as eye-pieces, and the effect thereby be improved; though the lenses should have a focal length of thirty or forty inches. The mirrors should be made of the best plate glass. The size may be much larger than the breadth of a window; although not to any very great advantage.

To see near objects in the telestereoscope, the reflectors must be turned round their vertical axes so that the angle between their surfaces and the long edge of the box is somewhat greater than 45°. The objects then appear greatly reduced in size, but in surprisingly prominent relief. When the large mirrors only are turned, the small ones being left at the angle of 45°, an exaggerated relief is obtained. If the dimensions in the direction of the depth of the field of view to those on the surface are to retain their right relations, the large mirrors must always remain parallel to the small ones. The aspects of near objects, particularly of the human figure, are strikingly beautiful in the telestereoscope. The impression differs from the reduction produced by concave glasses, in the circumstance that it is not reduced pictures that the observer imagines he sees, but actually reduced bodies.

Magnifying power may easily be connected with the telestereoscope: it is only necessary to place a double opera-glass between the eyes of the observer and the small reflectors; it is still preferable for the field of view, to separate the eye-glass from the object-glass of the instrument, and so fix them in the telestereoscope that the light at each side first strike the large mirror, then the object-glass, then the small reflector, and finally the eye-glass; so that in this arrangement the optic axis of the telescope itself is broken at a right angle. The greater the magnifying power, the greater of course must be the perfection of the plane reflectors, but then it is not necessary to choose them larger than the object-glass of the telescope.

These views, at the same time telescopic and stereoscopic, also exceed to an extraordinary degree the common image of the telescope in vividness. In the simple telescopic images, difference of distance disappears totally: the objects look exactly as if they were painted on a plane surface. By the ordinary combination of the two Galileo's telescopes, the appearance of relief for nearer objects is in some degree obtained; and hence it is that a double opera-glass gives a much livelier impression of relief than a single one. But in the usual construction of the instrument the relief is false: the objects appear as if they were squeezed together in the direction of depth. In the case of human faces, on which, for the most part, opera-glasses are directed, this is very striking. When they are regarded from the front, they appear much flatter than they really are, and when looked at in profile, they appear too narrow and sharp. In both cases the expression of the countenance is essentially altered.

When a double opera-glass is turned round and the observer looks through the object-glass, the deep dimensions of objects are magnified out of proportion. While, therefore, through a simple telescope all objects appear as paintings, through a double opera-glass, complete objects are seen as *bas-reliefs*, while by reversing the opera-glass, objects appear in high relief.

2. *Inquiries into the Quantity of Air inspired throughout the Day and Night, and under the influence of Exercise, Food, Medicine, Temperature, &c.*, by Edward Smith, M.D., (Proc. Roy. Soc., L. E. and D. Phil. Mag., xiv, p. 546).—This communication consists of three parts and contains the results of 1200 series of observations. The author was himself the subject of all the investigations. He is thirty-eight years of age, six feet in height, healthy and strong, and with a vital capacity of the lungs of 280 cubic inches.

The paper concludes with a summary of the principal results obtained and a series of deductions, applicable especially to the solution or elucidation of hygienic questions. From the former the following facts are extracted:—

The total quantity of air inspired in 24 hours (allowance being made for intervals amounting altogether to 40 minutes, during which it was not recorded) was 711,060 cub. ins.; or an average of 29,627 cub. ins. per hour and 493·6 per minute. The quantity was much less during the night than during the day. There was an increase as the morning advanced and a decrease at about 8^h 30^m P. M., but most suddenly at about 11 P. M. During the day the quantity increased immediately after a meal,

l then subsided before the next meal; but in every instance it rose in immediately before a meal. The rate of frequency of respiration erally corresponded with the quantity, but the extremes of the day l night rates were greater. The period of greatest parallelism was ween tea and supper. An increase was occasioned by one meal only, nely breakfast. The average depth of respiration was 26·5 cub. ins., h a minimum of 18·1 cub. ins. in the night, and a maximum of 32·2 ı. ins. at 1^h 30^m P. M. The mean rate of the pulse was 76 per min-, the minimum at 3^h 30^m A. M., the maximum at 8^h 45^m A. M.; the erence being more than one-third of the minimum rate.

Sleep came on in two of the series of continuous observations, and the e of its occurrence was also that of the lowest quantities of air in-ed.

The amount of breathing was greater in the standing than in the ing posture, and greater sitting than lying. It was increased by riding horseback, according to the pace, also by riding in or upon an omni-. In railway travelling the increase was greater in a second- than in rst-class carriage, and greatest in the third-class and on the engine. increase was also produced by rowing, swimming, walking, running, rying weights, ascending and descending steps, and the labor of the ıd-wheel; and in several of these cases the rate of increase was de-nined for different degrees of exertion used. Reading aloud and ging, and the movement recommended by Dr. Hall for restoring sus-ded respiration, increased the quantity; bending forwards whilst sit-g, lessened it.

The quantity of inspired air was increased by exposure to the heat l light of the sun, and lessened in darkness. Increase and decrease of ficial heat produced corresponding effects; and the depth of respira-ı was greatly increased by great heat. An increase in quantity was sed also by cold bathing, and sponging, and the cold shower-bath; breakfast, dinner, and tea—when tea actually was taken, but when fee was substituted there was a decrease. Supper of bread and milk) caused a decrease. Milk by itself or with suet caused an increase.

An increase was obtained with the following articles of diet, viz.: eggs, f-steak, jelly, white bread (home-made), oatmeal, potatoes, sugar, tea, ı (1 oz). The following caused a decrease, viz.: butter, fat of beef, 'e oil, cod-liver oil, arrow-root, brandy (1 oz. to 1¾ oz.), and kirchen-sser. Ether (½ drachm) increased the quantity and depth of inspira-ı. A decrease in quantity was caused by sp. ammon. co. (ʒiss), sp. mon. fœt. (ʒiss), tincture of opium (20♏), morphia (¼ and ⅛ gr.), tarized antimony (½ gr.), and chlorid of sodium.

Carbonate of ammonia (15 grains) caused a small increase at first and n a small decrease; febrifuge medicines had a like effect. Chloroform ♏ and ʒss), by the stomach, varied the quantity from an average in-ase of 28 cub. ins. to an average decrease of 20 cub. ins. per minute; h a maximum increase of 63 cub. ins. per minute. Chloric ether (ʒss)) varied the quantity, but there was an average increase of 17 cub. per minute, and of 1·8 per minute, in the rate; whilst the pulse fell the average 1·7 per min. Chloroform, by inhalation (to just short of consciousness), lowered the quantity a little during the inhalation, and

more so afterwards. The rate was unchanged, but the pulse fell, on an average, 1·7 per min. Amylene similarly administered and to the same degree, increased the quantity during inhalation 60 cub. ins. per min., but afterwards decreased it to 100 cub. ins. per min. less than during the inhalation. The rate of respiration was unchanged: the pulse fell 6 per min. at the end of the observation.

Digitalis (infusion ℥i) varied the quantity, increasing it at first and then decreasing it. The rate of inspiration was unaffected, whilst that of pulsation somewhat increased.

The paper is accompanied by tables of numerical statements, and by diagrams exhibiting the results in a series of curves.

3. *Fluorescence.*—Prof. J. W. Mallet states in a letter to one of the editors of this Journal (dated Tuscaloosa, Ala., Jan. 29) that an old solution of oil of orange-flowers (Oleum Neroli) in alcohol—one part of the former to twelve or fifteen of the latter—fluoresces strongly with a beautiful pale purplish light. The solution was made some six or seven years ago, and did not exhibit this phenomenon at first.

4. *A System of Instruction in the Practical Use of the Blowpipe, being a graduated course of analysis for the use of Students and all those engaged in the examination of metallic combinations.* 268 pp., 12mo. New York, 1858. H. Bailliere.—The use of the blowpipe has been so thoroughly perfected by Berzelius and Plattner that now-a-days it is hardly possible to produce an original treatise on this subject. Those who have hitherto undertaken to prepare blowpipe manuals, have wisely followed the accurate observations of these masters, and have reproduced them in a more or less altered form and arrangement, to suit the convenience of students. The book before us is acknowledged to be chiefly a copy, but it is eminently and unfortunately original.

The work is due, as appears from the publisher's advertisement, to Prof. J. Milton Sanders of Cincinnati, Ohio, though a modest S. appended to the Preface is all of the name the present volume contains. We had occasion recently to criticise a publication issued over the same name; and we could wish that now we had only to commend. But we should not be just to good English or good science if we were so to treat it.

Besides much incorrect use of plain English, we find German idioms strangely intruded on the language of the laboratory, and also misunderstood. He says, "If insoluble substances are fused with others for the purpose of causing a combination which is soluble in water and acid, the operation is called *unclosing*" (aufschliessen?). Again, "If we detonate (as it is termed by the German chemists) the sulphide of antimony or the sulphide of arsenic with nitrate of potash, we get the nitrate of antimony or *nitrate of arsenic.*" We are not aware that either our own or the Latin language is indebted to the Germans for the word *detonate*, and moreover we do not see any propriety in its use in that place. The author may have meant to say *deflagrate*, though this would not be a term from the German chemists. The science of the passage is its most extraordinary feature; for we have here announced for the first time in the history of chemistry, the existence of a *basic oxyd of arsenic and its nitrate*—a fact not even mentioned in the 4th American edition of Gregory's Chemistry, edited by Prof. Sanders himself!

The above may be enough to exhibit both the literary and scientific merits of the work. We would not however do the author injustice, and therefore make a few other citations. The italics beyond are ours.

Page 160 we read: "Arsenic acid (AsO^5) is a white mass which readily absorbs moisture and dissolves. It will not volatilize at a low red heat, *nor will it decompose*. Exposed to a strong heat it is decomposed, yielding oxygen, and passing into arsenious acid." Under arsenious acid we are told that "Upon charcoal it *instantly* volatilizes, and *when heated* the characteristic garlic smell is perceived."

Of silver is said (p. 163), "it is *not* oxydizable, *neither* at common temperatures *nor* at those which are considerably higher." The merest tyro in chemistry will henceforth have an infallible means of recognizing this useful metal. On page 59, in describing the behavior of silver on charcoal before the blowpipe, the language of Plattner and Scheerer being nearly followed, and also on page 264, where Blanford's account of the reactions of native silver is copied—the well known red deposit of oxyd of silver formed when the metal or its oxyds are strongly heated on charcoal is of course duly noticed; but in the chapter on *Special Reactions*, which appears to be the most original part of the work, in giving the general characters of his "ninth group" of metals, viz., copper, silver and gold, Prof. S. states that: "In the reduction of the oxyd of this group no sublimate is visible on charcoal."

Platinum is repeatedly said to be infusible. We are however in the habit of showing to our classes the fusion of a fine wire of this metal in the flame of the mouth blowpipe in accordance with the observations of Fiedler, Plattner and others.

According to the author, boracic acid bleaches brazil-wood-paper, but nothing is said of the action of sulphurous acid, the latter having this bleaching effect while the former has not. We also learn that phosphoric acid tinges it yellow in the same manner as hydrofluoric acid.

The blowpipe is concisely described in the following language. "It is generally made *in the form of a tube* bent at a right angle, but without a sharp corner. The largest one is about seven inches long, and the smallest about two inches." This of course refers to the common blowpipe; but the hand blowpipe used for chemical purposes does not seem to be "made in the form of a tube" if we rightly understand the following description. It "is composed of the following parts: (fig. 1) A is a little reservoir made *air-tight* by grinding the part B into it."

After 178 pages of the proper treatise on the blowpipe, the author finishes his labors by copying bodily, typographical errors included, about 90 pages from Blanford on the Behavior of Minerals before the Blowpipe, which his preface thus acknowledges; we quote the paragraph as an example of his style: "In Part Third of this work, commencing at page 109, the student will find a sufficiently explicit description of the blowpipe reactions of those principal substances that would be likely to come *beneath* his attention. The following tabular statement of those reactions—which we take from Scheerer and Blanford's excellent little work upon the blowpipe—will be of great benefit, as a *vehicle for consultation*, when the want of time—or during the hurry of an examination—precludes the attentive perusal of the more lengthy description in the text."

5. *Lectures on Roman Husbandry*—delivered before the University of Oxford, comprehending such an account of the System of Agriculture, the Treatment of Domestic Animals, the Horticulture, etc. pursued in ancient times, as may be collected from the Scriptores Rei Rusticæ, the Georgics of Virgil, and other classical authorities, with notices of the plants mentioned in Columella and Virgil; by Professor CHARLES DAUBENY, M.D., F.R.S., etc., Professor of Botany and Rural Economy in the University of Oxford. 328 pp., 8vo. Oxford and London, 1857.—The scientific and classical world are under equal obligations to the learned author for his valuable and attractive work on the condition of agriculture and horticulture, and the breeding of domestic animals, in the most flourishing period of the Roman power. The author alludes in his preface to his indebtedness to the earlier treatise of the Rev. Mr. Dickson on the "Husbandry of the Ancients," published in 1788, but states that he has embraced a wider range of topics, adding to the subject of tillage that of the culture of the vineyard and orchard, the treatment of domestic animals of all kinds, the cultivation of the garden and other collateral topics. Dr. Daubeny has brought to the task a familiar acquaintance with classical learning as well as with the sciences pertaining to the subject. As a chemist and botanist and also a man of general science he has long been known. It is impossible, within the limits of a brief notice, to present an analysis of a work which is itself an analysis of the ancient authors on the subjects referred to. The impression left on the mind of the reader is, that of an interesting and instructive review of antiquity; we travel along pleasantly with the author through his learned and agreeable volume.

The work is illustrated by a plan of Pliny's Laurentian villa and grounds, another of a Villa Urbana Rustica and Fructuaria according to Columella, of a Garden and Portico at Pompeii, pictures of agricultural operations from Egyptian monuments, ancient Greek agricultural implements, plan of an Egyptian garden, and drawings of plants mentioned by ancient authors. B. S.

6. *Medical Lexicon: A Dictionary of Medical Science, &c.;* by ROBERT DUNGLISON, M.D., LL.D., revised and very largely corrected. Philadelphia: Blanchard & Lea. 1857. 8vo, pp. 992.—This accomplished and learned author here presents us with a thoroughly revised edition of his *Lexicon* of medical terms. It is prepared with great care and in the widest and most catholic spirit. The literary and the mechanical execution of the work are remarkably accurate and satisfactory. Good lexicons and encyclopedic works generally, are the most labor-saving contrivances which literary men enjoy; and the labor which is required to produce them in the perfect manner of this example is something appalling to contemplate. The author tells us in his preface that he has added about six thousand terms and subjects to this edition which before was considered universally as the best work of the kind in any language.

7. *Cosmos.*—Humboldt, in a letter to the German Association of Naturalists and Physicians, recently published, announces that a new volume of the Cosmos (the first *Abtheilung* of the fourth and last *Band*) is almost ready for publication. It will present, as a counterpart to the third volume on Uranologie, an introduction to the special presentation of Terre-

trial phenomena. The contents are stated as follows. Book I: Size, Shape and Thickness of the Earth, Internal Heat, Magnetic Activity of the Earth, Intensity, Inclination, Declination, Magnetic Equator, Four Points of the Greatest Intensity, Curve of the Weakest Intensity, Extraordinary Disturbances, Magnetic Storms, Polar Light. Book II: Reaction of the Interior of the Earth upon the Surface, Earthquake, Thermal Springs, Volcanoes, Naphtha Springs, Volcanic Phenomena.

The second part of the fourth volume, which will complete the whole work, will contain, Classification of Mountains and Strata according to their different modes of origin, Conformation of Plains, the Sea and its Currents, the Atmosphere, Meteorological reflections, Isothermal Lines, Organic Life, Geography of Plants and Animals.

8. *Graham's Chemistry*, Vol. II.*—This long expected volume is at last published, forming volume xiii of Mr. Bailliere's 'Library of Illustrated Scientific Works.' It is a very acceptable addition to the library of standard books of every chemical student. Mr. Watts, well known as the translator of the Cavendish Society edition of Gmelin's Chemistry—has made in the Supplement an able resumé of the progress of the science since the publication of the first volume. It is plain from the number and importance of the topics there discussed that great progress has been made in the interval both in chemical physics and in general inorganic chemistry. The best thing the enterprising publisher can now do is as soon as possible to reprint the whole work and incorporate in their proper places the various topics forming the Supplement of 320 pages. But as it is, no reader of English works on this science can afford to be without this edition of Prof. Graham's Elements. A mention of some of the topics discussed will justify this assertion. We find the new methods of Volumetric Analyses detailed, with a description of Bunsen's General Method, the Mechanical Equivalent of Heat, the Mechanical and Chemical Measure of the effects of the Electric Current, Pasteur's observations on the remarkable relations between Crystalline form and Molecular rotary power. The modern views of the constitution and classification of Chemical Compounds are explained at considerable length chiefly according to Gerhardt's Unitary System. The work is beautifully printed, and, as far as we have examined it, praiseworthy in its freedom from typographical errors.

9. *Life of Dr. E. K. Kane;* by Dr. Wm. Elder. Philadelphia, 1858. Childs & Petersen. 8vo, pp. 416.—Every thing connected with the romantic and self-sacrificing life of Dr. Kane is read with avidity by people of all conditions. Dr. Elder's memoir is a glowing eulogy of his hero. The most valuable portions of it are the numerous extracts from the letters and manuscripts of Dr. Kane, picturing his various wanderings in Africa, Asia and Europe.

10. *American Association for the Advancement of Science.*—The next meeting of the Association will be held at Baltimore, commencing with the last Wednesday in April. Prof. Jeffries Wyman of Cambridge is President elect for the coming year.

* Elements of Chemistry, including the Application of the Science to the Arts, by Thos. Graham, F.R.S., L. & E. 2d edition, edited by Henry Watts, B.A., F.C.S. New York, Chas. E. Bailliere, 1857. 8vo, pp. 804.

O. Reichenbach: Einige Gedanken eines Nichtgelehrten bei Lesung des Kosmos. 138 pp. 12mo. Philadelphia, 1857.

Boston Journal of Natural History, Vol. VI, No. IV. Contents.—Art. XXV, New Species of Fossil Plants from the Anthracite and Bituminous Coal fields of Pennsylvania, by Leo Lesquereux, with introductory observations, by H. D. Rogers. —Art. XXVI, Observations on the Development of *Anableps Gronovii*, by Jeffries Wyman.—Art. XXVII, On the Crustacea and Echinodermata of the Pacific shores of North America, by W. Stimpson.—Art. XXVIII, A list of the Fishes collected in California by Mr. E. Samuels, with descriptions of new species, by C. Girard.

Journal of the Academy of Natural Sciences of Philadelphia. New Series, Vol. III, Part IV.—Art. XIX, Descriptions of Exotic Genera and Species of the Family Unionidæ, with plates 21 to 33, by I. Lea.—Art. XX, Observations on a group of Cretaceous Fossil shells, found in Tippah Co., Miss., with descriptions of fifty-six new species, with plates 34, 35, by T. A. Conrad.—Art. XXI, On the Caducibranchiate Urodele Batrachians, by E. Hallowell.—Art. XXII, On Trigonophrys rugiceps, and plate 36, by E. Hallowell.

Proceedings Acad. Nat. Sci. Philad., 1857.—p. 101, Six new species of Fresh-water and Land shells of Texas; *I. Lea.*—p. 102, Examination of a Nickel Meteorite from Mississippi; *W. J. Taylor*—p. 109, Notes explanatory of a Map and Section illustrating the Geology of the Nebraska Territory; *F. V. Hayden.*—p. 117, Descriptions of New Fossils from the Nebraska Tertiary and Cretaceous; *Meek* and *Hayden.*—p. 148, On the Larva of Thyreus Abbottii; *J. P. Kirtland.*—p. 149, 150. Bone and Coprolite from the New Red Sandstone of Pennsylvania; *J. Leidy.*—p. 150, The Insectivorous mammal of the New Red of N. Carolina, named *Dromatherium sylvestre* by Emmons, is closely allied to the Spalacotherium of Owen from the English Purbeck beds of the Oolitic formation; *J. Leidy.*—Change of the generic name of fossil fishes *Mikolepis* to *Eurylepis; J. S. Newberry.*—p. 151, Notes on the Geology of the Mauvaises Terres, Nebraska; *F. V. Hayden.*—p. 159, Prodromus descriptionis Animalium evertebratorum, &c., Annelides; *W. Stimpson.* —p. 165, Descriptions of two new genera of shells, one including a species near Anodonta from the Sacramento, the other an Eocene fossil hitherto referred to Rostellaria, and named *Calyptraphorus* (*C. velatus*, being Rost. velatus, of Conrad, Tert. Foss., p. 38, pl. 15, f. 4); *T. A. Conrad.*—p. 166, Rectification of some generic names of U. S. Tertiary fossils; *T. A. Conrad.*—A new *Myacites* from the Black shale of the New Red Sandstone of Pennsylvania; *T. A. Conrad.*—p. 167, A new genus, *Mytilopis*, related to Mytilus; *T. A. Conrad*—p. 167. Notice of some remains of extinct Fishes (Cretaceous, Tertiary and New Red); *J. Leidy.*—p. 168, Examination of Enargite; *W. J. Taylor.*—p. 169, Descriptions of 27 new species of Uniones from Georgia; *I. Lea.*—p. 173, Fish scale from Red Sandstone formation of Gwynned, Pa., probably identical with *Radiolepis speciosus*, Emmons, of N. Carolina; *I. Lea.*—p. 174, On three new species of Vespertilionidæ; *John LeConte.*—Rectification of the references of certain of the Extinct Mammalian Genera of Nebraska; *J. Leidy.* —p. 176, Dentition of Mosasaurus; *J. Leidy.*—p. 178, Note on Insect wax of China. —The Atlantic fishes, *Exocetus acutus*, *Pristipoma Rodo*, *Ephippus Faber*, found at Panama in the Pacific.—p. 179, Observations on the Wild Turkey, Gallopava sylvestris; *J. LeConte.*—p. 181, 195, New Reptiles collected in Wilkes's Expl. Exp.; *C. Girard*—p. 183, Notes on American Land Shells; *W. G. Binney.*—p. 200, Notice of new genera and species of Marine and Freshwater Fishes from Western North America; *C. Girard.*—A new Cypselus from Puget Sound; *C. B. R. Kennerly.*—Notes on Gordius, larves of an Œstrus in a pouched rat, a new animalcule; *J. Leidy.* p. 205.—p. 206, On the experiment of introducing the Camel into America; *Dr. Hammond.*—p. 213, On N. American species of Archibuteo and Lanius and description of a new Toucan; *J. Cassin.*—p. 215, New North American Reptiles; *E. Hallowell.*—p. 216. Prodromus Descriptionis An. everteb. &c., Ringgold and Rodgers' North Pacific Expedition,—Species of Crustacea (*Maioids*); *W. Stimpson.*—Annual Reports.

APPENDIX.

1. *On Permian Strata in Kansas Territory;* by Prof. G. C. SWALLOW. (From a letter to J. D. DANA, dated Columbia, Missouri, Feb. 16, 1858.)

I have just finished the examination of a collection of fossils from Kansas Territory, made by Maj. Hawn, who was formerly connected with our Survey. The larger part of the collection is from the Upper Coal Measures; but by far the most interesting part can not be referred to the Carboniferous, or to any other formation heretofore known to exist in the West.

From the beds in doubt there was but one known Carboniferous species, *Terebratula subtilita* of Hall. It is quite certain they are not Cretaceous. After a somewhat careful comparison with the Permian fossils of Russia, we are satisfied that they are *Permian.*

Three out of the four species of corals, are without doubt Permian.

Thamnicus dubius, King, is certainly in our collection.

Thamnicus. Species undetermined, but identical with a Permian specimen figured in the Geol. Trans., 2d Series, vol. iii, pl. XII, fig. 7.

Fenestella retiformis, King. Our specimens are identical with the Russian species referred doubtfully to this, by Mr. Lonsdale, Geol. Russia, p. 630.

Schizodus Rossicus, Vern., Geol. Russ. pl. XIX, figs. 7 and 8. We have many specimens of this Permian species. Both varieties and the intermediate forms are represented.

Avicula antiqua. Geol. Russ., pl. XX, fig. 13.

Productus horrescens, Vern., Geol. Russ. pl. XVIII, fig. 1. Our collection contains specimens which are more nearly allied to these than to any other known species.

We also have species which are very nearly if not quite identical with *Murchisonia subangulata*, Vern., *Mytilus Pallasi*, Vern., *Solemya biarmica*, Vern., *Ostodemia Kutorgana*, Vern., of the Permian in Russia and *Cardinia Listeri* of the English Lias. We also have one or two species of *Monotis*, a genus seldom, if ever, extending down into the Carboniferous.

I can but feel that the above is sufficient to justify us in the decision that they are *Permian.* I know of no other formation in the country, whose fossils would give so large a proportion of species identical and analogous with those of any one locality in Europe.

We have as yet compared them with none but the Russian species by Verneuil. When the examination is completed I will give you the result more in detail.

2. *New Determination of the Sun's Parallax.*—In a letter to the Hon. I. Toucey, Secretary of the Navy, dated Feb. 18, 1858, Prof. J. M. Gilliss communicates as one result of the observations on Venus and Mars made by the U. S. Astronomical Expedition to Chili in 1849–1852, compared with simultaneous observations in the Northern hemisphere, that the Sun's Equatorial Horizontal Parallax is $8''\cdot4950$, or $0''\cdot0762$ less than the value commonly adopted; corresponding to a mean distance of the Sun from the earth of 96,160,000 statute miles.

THE

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JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXVII.—*Geographical Notices.*—No. I.

IT is proposed to give in this journal from time to time notices of new geographical discoveries and explorations, particularly accounts of scientific expeditions in different parts of the world. In preparing these articles, free use will be made of the best European journals and especially of the excellent repository edited by Dr. Petermann at Gotha, *Die Geographische Mittheilungen.*

As this periodical is new and not widely circulated in America we desire to call particular attention to its value. It was commenced in 1855 at Gotha under the editorial charge of Dr. A. Petermann, who has long been distinguished for his geographical labors. Twelve numbers appear in the year, each containing one or more new maps, for the most part admirably engraved. The editor has a wide correspondence in different parts of the world and his relations with various scientific men in England, Germany, and America, are such that he is able to give early and reliable intelligence in respect to all important explorations. In addition to the discussion of specific questions, particular attention is paid to a review of new geographical literature.

The necessity of giving, at the outset, a wide survey of investigations which are now in progress, precludes, in the present article, the possibility of so much detail as would otherwise be desirable.

AFRICA.

Barth's Travels. Dr. Vogel.—Particular attention is now directed toward Africa from all civilized countries, and explorations are in progress at numerous points. The publication in Germany and England and the reprint in America of the first three volumes of Dr. Barth's Travels in North and Central Africa, followed immediately by the publication of Dr. Livingstone's work on his journey and residence in South Africa gives especial interest to all expeditions on that continent. These important volumes being generally accessible it is unnecessary to state here their character. It is however desirable that students should know that the relations of Barth's work to other previous and cotemporaneous journies are well shown in Map No. 1 of the English edition, but this and all the other maps of that edition are omitted in the American reprint. An outline map only, which originally appeared months ago in Petermann's Mittheilungen, is given in the New York edition.

Kiepert's new *Wand-Atlas*, Lieferung 2, embodies the more important of Barth's topographical determinations. So to a less extent does a map in the new Encyclopædia Britannica, illustrating an article on Africa which is attributed to Dr. Petermann.

Letters have just been received in Germany which were sent home by Dr. Barth three years ago. They contain much interesting matter not before published, in respect to his final residence in Timbucktu and his journey on the Niger to Gogo. They are printed in Petermann's *Mittheil.*, vol. iii, Nos. 9 and 10, in advance of the publication of the fourth and fifth volumes of Barth's Travels.

Hopes are still entertained that Dr. Vogel, one of Barth's companions, was not murdered as reported, but is still alive. Directions have been forwarded by the British Government to their Consul at Chartum directing him to make all possible inquiries in respect to the fate of this intrepid traveller.

On the other hand, letters have been received in England and Germany from Cairo, mentioning the arrival of an Envoy from the Sultan of Dar Fur, who states that Vogel was murdered at Wadai by command of the prince of Wadai.

Later dates say that Baron Neimann, who has lately been traveling in Arabia, having heard that Vogel was yet in imprisonment at Wadai, had determined to go and ascertain.

Dr. Livingstone's return to Africa.—Dr. Livingstone it is announced will return immediately to South Africa. His plan of operations there is thus stated in Sir R. I. Murchison's Anniversary Address before the Roy. Geog. Soc. of London. "His aim, when he returns to Quilimane and Tete in the spring of 1858, or the first period of the healthy season, and after he has rejoined

his old companions the Makololo, who are anxiously waiting for him, will be to endeavor to establish marts or stations beyond the Portuguese colony, to which the inhabitants of the interior may bring their goods for sale, and where they may interchange them for British produce. At these stations, which will be in those flanking, high grounds of the African continent that he has described as perfect sanatoria, he will endeavor to extend the growth of cotton, as well as to teach the natives how to till their lands, taking out with him for these intents cotton-seed, gins, ploughs, &c. He will further endeavor to bring to the English market a vegetable called Buàze, which possesses so tough and fibrous a tissue as to render it of great value even to the natives in their rude manufactures. Specimens of this plant, which grows in profusion on the north bank of the Zambesi, have been converted into a substance that has been pronounced by a leading manufacturer to be worth, when prepared, between fifty and sixty pounds per ton, and applicable to all purposes for which flax is employed. In this material, therefore, alone, to say nothing of indigo, cotton, beeswax, ivory, and the ores of iron, with much good coal, we have sufficient indication that no time should be lost in establishing a regular intercourse with the natives of so prolific a region.

"Thus, acting as the pioneer of civilization, Dr. Livingstone will first engage the good will of the natives through their love of barter, and, having secured their confidence by honesty of purpose, he will the more readily be able to lead them to adopt the truths of that religion of which he is a minister, and of the value of which his whole life is a practical illustration."

Dr. Livingstone himself, in a speech at the Farewell Banquet given to him in London, February 14, expresses a hope that he shall find, through that part of the country which he has already explored, a pathway by means of the river Zambesi, which may lead to highlands where Europeans may form a settlement, and where, by opening up communication and establishing commercial intercourse with the natives of Africa, they may slowly but not the less surely impart to the people of that country the knowledge and the inestimable blessings of Christianity.

With the aid of Captain Bedingfield, who accompanies him, he hopes to ascertain the principles of the river system of that great continent; and if he finds that system to be what he thinks it is, he proposes to establish a dépôt upon the Zambesi, and from that station more especially to examine into that river system, which, according to the statements of the natives, would afford, if discovered, a pathway to the country beyond, where cotton, indigo and other raw material might be obtained to any amount.

Men experienced in geology, botany and photography are also to join in this expedition, and under a leader of such acknowledged ability important results may be anticipated.

It is proper to remark that Mr. W. D. Cooley, who has long been distinguished for his attention to African geography, disputes* many of Dr. Livingstone's generalizations and inferences in respect to the structure of the southern portion of the continent, and especially his statement of the union of the Leeambye and the Zambesi.

Niger Expedition.—A new expedition sent out by the British Government under a contract with Mr. Macgregor Laird is engaged in exploring the regions watered by the Kwara or Niger and its tributaries. It is commanded by Dr. Baikie who had visited the same region in 1854, and is now accompanied by his former companion Mr. May, R. N., and by other scientific men.

The objects of the expedition as organized by the English Admiralty are, "to explore the river Niger and its tributaries, to ascertain the natural productions and capabilities of the countries through which they flow, to enter into friendly relations with the Native chiefs, to facilitate the return of liberated Africans to their homes, and practically to show the advantages of legitimate trade over the debasing and demoralizing traffic in slaves."

An iron screw-steamer the "Day Spring," 170 tuns burthen, combining 30-horse power with less than five feet draught of water, was originally employed by this party; but it has lately been lost above Rabbat and its place will be supplied by another vessel, the "Sunbeam."

The party, consisting of twelve Europeans and forty liberated black seaman, was to proceed up the river to Rabbat. Sakatu was then to be visited, and also Isai and Busah. The neighborhood of the confluence of the Benue or Tchadda and the Kwara was then to be examined with reference to the establishment of an English commercial station. In another season the Benue is to be ascended, and the regions of Adamawa and Hamarrawa are to be explored, and perhaps the higher part of the Old Calabar river may be reached.

The geological instructions of this expedition were prepared by Sir R. I. Murchison, who expresses the hope (in his annual address before the Royal Geographical Society, from which some of the above facts are taken) that much mineral wealth is to be found.

"In fact," he says, "if the survey be completed in the manner devised, the whole western side of Central Africa will have been so traversed, as to yield two important sections, which cannot fail to give us the knowledge we desire. The Niger or Kwara flows

* London Athenæum, Feb. 13, 1858.

in a gorge across such thick ribs of rocks as must surely enable the travellers to read off a clear lesson, whilst an excursion from the upper part of the Tchadda to the sources of the Calabar, on the one hand, and to the heights of Aed Hamarrawa on the other, will also afford an instructive parallel traverse of no less importance."

The Escayrac expedition to the Nile.—An expedition, paid for by the Viceroy of Egypt, and placed under the direction of the French geographer Count Escayrac de Lauture, to explore the sources of the White Nile, has been abandoned on account of dissensions among the members of the party. Its appointed head, in a letter to the Paris "Presse," expresses his belief that an armed force is necessary to accompany such an expedition as he had under command.

Roman Catholic Mission to the Upper Nile.—A mission, founded at Chartum in 1846 by Pope Gregory XVI, and continued in that region until now under different leaders and in spite of many difficulties, has made known many interesting facts in respect to the people and country of the Upper Nile, which are published at Vienna in the Annual Reports (from 1852 to 1857) of the Mariens-Verein für Beförderung der katholischen Mission in Central-Afrika. The three journies of Father Knoblecher to Gondokoro especially deserve mention.

Heuglin's Journey in Abyssinia.—Th. von Heuglin, of the Austrian consulship at Chartum made, in 1852–3, extended travels in Abyssinia, with a view to the establishment of friendly relations with that country. We have just received an account of the journey, published in Gotha. The flora and especially the fauna of that region are noticed by the author. The volume contains an original profile of the country between the mouths of the Gandowa and the Takkasi valley, a map and some other illustrations.

Major Burton on the Coast of Zanzibar.—Major Burton, who is exploring the coast of Zanzibar, has been heard from as far in the interior as Fuga, some eighty miles from the coast. His observations may be expected to settle definitely the disputed point whether or not there are snow-covered mountains near the equator and the extent of the great sea Uniamesi.

Hirsch on Algiers.—Special efforts have been made within a few years past by the French government to turn toward Algiers the stream of German emigration which would naturally flow toward America. With reference to this, Dr. Max Hirsch has published a volume entitled "Skizze der volkswirthschaftlichen Zustände von Algerien," (Göttingen, 1857,) in which he briefly states many important facts concerning the capabilities of Algiers, promising a fuller account of his travels at no distant day. He opposes German emigration in that direction.

Soundings and Surveys near the African coast.—The following information is derived from the Address, before mentioned, of Sir R. I. Murchison:

"On a recent route from Malta to the Dardanelles, Captain Spratt had an opportunity of obtaining a line of deep-sea soundings between that island and Candia in which the greatest depth was 2170 fathoms. The section is very striking; for a distance of 50 miles to the eastward of Malta the depth does not exceed 100 fathoms, after which it drops almost suddenly to 1500 and 2000 fathoms, and continues near that level *below* the surface of the sea until within 20 miles of the east end of Candia or Crete, where the White Mountains and Mount Ida rise up to a nearly equal height *above* the level of the sea. Between Crete and the Dardanelles the greatest depth is 1110 fathoms.

On the North coast of Egypt, Commander Mansell in the Tartarus, with his assistants Lieut. Brooker and Mr. Skead, have completed a survey of the coast from Damietta eastward to El Araish, an admirable plan of the port of Alexandria, and a survey of the Bay of Suez, a place daily becoming of more importance, as our direct mail communication extends to India, China, and Australia.

While on this subject I should mention, that in October, 1856, Messrs. Delamanche and Ploix, Ingénieurs Hydrographes of the French Imperial Marine, carried a line of soundings across the Mediterranean between Port Vendres in France and Algiers, in which the greatest depth was about the same as in the Levant, namely 1600 fathoms."

In the Nautical Magazine, Captain Mansell reports the following soundings between Alexandria and the west end of Rhodes.* The first column gives the miles from Alexandria, the second the depth in fathoms, and the third the nature of the bottom.

10	110	Sand and mud.	110	1550	Yellow mud.
20	200	Sand and coral.	130	1600	" "
30	450	Fine black mud.	150	1600	" "
50	850	Yellow mud.	170	1500	" "
70	1000	" "	200	1300	" "
90	1300	" "			

Between the west end of Rhodes and Nicasia he obtained these soundings:

10	500	Yellow mud.	55	1400	Yellow mud.
30	920	" "	75	1350	" "

ASIA.

The Brothers Schlagintweit in India.—The report of the brothers Schlagintweit (well known from their earlier journeys in the Alps) in respect to their recent travels in India, and especially

* v. Peterm. Mitth., vol. iii, No. 12.

their visit to the Trans-Himalayan chain of Kuenluen, may be looked for at an early day. Notwithstanding the jealousy with which this expedition has been regarded in England,* there is reason to believe that it will make important additions to our knowledge of that region.

In Petermann's Mittheilungen, 1856, p. 104, there is an outline map of the route which the brothers followed. Robert Schlagintweit gave, before the British Association in August last, a brief sketch of the journey, which is thus reported in the Athenæum:

"In 1854 they reached India, and passed from Bombay to Madras through Central India, each by different routes, making geological, geographical, and other scientific investigations as they proceeded. On their sea voyage, previously, they had made observations as to the specific gravity of sea water, and also as to the currents of the sea, and continued these in the voyage from Madras to Calcutta. On arriving at Calcutta, in the beginning of 1855, Hermann Schlagintweit set out for the northwestern provinces of Bengal, and, having reached Sikkin, continued their researches all along the Himalayas, with a view of ascertaining their height, and the characteristics of the places, from that until they came to the high mountain of Nepaul, which was lately called Mount Everest by Col. Waugh, after his distinguished predecessor. This is the highest mountain in the world at present known, being considerably over 29,000 feet above the level of the sea. The natives have two names for it—one of them, Gorishanta, which is mythological, is to be found only in the Nepaulese, and the second name Chingofanmara, is that by which it is known among the people of Thibet. The name Deodunga, which was mentioned by Mr. Hodgson in connexion with this peak, was not the name of it at all, but of a small mountain some 8,000 feet high, which lies in the same direction.

"After leaving Sikkin, Hermann, having examined part of Bhostin, the Himalayas, and Upper Assam, returned to Calcutta, by Brahmapootra and the delta of the Ganges. Robert and his brother Adolphe, left Calcutta in March, 1855, and after passing through the northwestern provinces, reached Natal, and then went to Milum, and thence to Thibet. They investigated the geographical and other features of the country as they went on: paying special attention to the alluvial deposit along the immense valley, the largest probably in the world. In this valley the Indus and the Dihong both take their rise, and flow in the one direction for hundreds of miles in parallel lines, separated only by a small rise in the surface of the valley. They then went to Abiganuri, and having encamped on a glacier there, at the height of 19,220 feet, on the evening of the 18th of August,

* See Athen., Feb. 6, 1858.

they succeeded on the 19th of August in reaching Abiganuri, at the height of 22,260 feet, the greatest height which had ever been attained on any mountain. They returned by different routes, each pursuing his inquiries.

"He then entered into some details respecting a journey which they took in the subsequent year to Central India, where they visited the plateau of Amerkantak, which is only about 3,300 feet in height above the level of the sea, though it is commonly supposed to be 8,000 feet. Four rivers take their rise in the neighborhood of this plateau,—the Nerbudda, the Soane, the Johilla, and the Mohamaddy. From this tour they returned to Simla by way of Delhi.

"H. Schlagintweit stated that he had arrived at the conclusion, that Western Thibet did not form a plateau, but was an undulating country; and one of the features of it near the Indies was the depression of the snow line to 17,900 feet, owing to the great amount of snow and rain which falls there. Sometimes the heat in the great valley of Balkistan, at an elevation of between 7,000 and 8,000 feet, even under the glaciers, is excessive, the thermometer from the 1st of July to the 20th marking 73 to 75 degrees Fahrenheit at the minimum, the maximum being sometimes 90 degrees. The snow line at Karakoin which they visited in a former journey after reaching the mountains of Nepaul, is the highest in the world, being 18,600 feet. That range of mountains it should have been observed, is called the Black Mountains, in opposition to the Himalayan range, which means the 'White Mountains.' The two ranges run parallel."

Adolph Schlagintweit remained in India for some months after his brothers, who returned to England in order that they might prepare and publish the results of their observations.

In one of the latest letters published from him the following particulars are given in regard to his recent course.*

"Having parted with my brothers at Rawul-Pindi in December, 1856, I went to Peschawur. Here I spent the greater portion of January, collecting with care as much geological and geographical information respecting the mountainous region to the west of Peschawur as it was possible to do without personal observation. . . . In the Salt-Chain, near Dehra Ismail Chan, I found much of geological interest; the stratified rocks are rich in fossil remains, and I secured many beautiful specimens from nearly every sedimentary formation, from the palæozoic to the miocene.

"The lowermost visible rocks are palæozoic; to the eastward of the Indus, these are found only along a narrow band, but on the other side of the river, as well as in the Kyber mountains, they have a much wider range. They contain a great variety

* Petermann's Mittheil., vol. iii, p. 287.

variety of fossil species,—long-winged Devonian Spiriferæ, Producti, Orthites, Terebratulæ, but no Trilobites. Next above the palæozoic strata we find gypsum and vast saliferous deposits. These are covered by a thin but distinct stratum of black slate, in which oolitic Ammonites and Belemnites abound. Close above the slate and evidently of the same period with it, is brown limestone in connection with coal. The coal is overlaid with strata of reddish sandstone, intermixed with occasional fossils. Still higher up there are large masses of whitish and yellow nummulite limestone, containing various fossils. The whole is covered with tertiary sandstone and conglomerate in which we find remains of quadrupeds. There are two very diverse formations of coal in these mountains; the one as mentioned above is oolitic, the other occurs in connection with fossils imbedded in the tertiary sandstone. But neither variety, so far as my observation has extended, is ever likely to possess any practical value, occurring as they each do, in such thin beds.

"Many of the fossils that I found here, are such exact counterparts of those that I had brought from the Himalayas and from Thibet, that I must conclude that the sedimentary stratified rocks of all these regions were formed under the same ocean.

"From Dehra Ismail Chan I went to the Mandi district. I found the salt here similar in formation and date to that of the Salt Chain. But the accompanying sedimentary strata have undergone extensive and multiform changes from the metamorphic action of those vast snow-capped shafts of feldspar which rise immediately back of the salt-mines to the height of 17,000 and 19,000 feet. In fact the alteration of rocks and the phenomena of metamorphism are, in my opinion, nowhere more strikingly manifest than in this locality.

"Having now finished my explorations in the salt-regions, etc., I am on my way to Kulu, whence I shall cross the lofty chain of the Dhauladhar and penetrate to the sources of the Ravi in the Tschamba District."

River Amur.—Russian travelers have lately examined the region of the Amur stream, in Eastern Siberia, and their observations, translated from the Russian, form the basis of a valuable article in Petermann's Mittheil., 1857, p. 296, in which the hydrography, ethnography, geology, zoology and botany of that river and the neighboring country are discussed. Aside from the scientific value of these researches they have a commercial bearing, an American steamboat having already ascended the river and regular trade being planned between that part of the Russian Empire and the United States. An excellent map accompanies the article in Petermann.

The Evening Post of March 19, contains a brief report from P. McD. Collins, United States Consul on the Amoor River, preliminary to a fuller report to be presented to the proper department at Washington, on the characteristics of Eastern Siberia and the feasibility of opening a direct trade with that country.

In this article Mr. Collins states that leaving Chetah, the capital of the Province of Trans-Baikal, on the seventh of May, 1857, he rowed, sailed and floated down the rivers Ingodah, Schilkah, and Amoor, to the Straights of Tartary, a distance of 2600 miles, in fifty-two days. His comments on the natural characteristics of the region are only general, but he is sanguine in respect to the openings for American commerce, and states that the Russian authorities have listened with favor to his proposition to build a railroad three hundred miles from Irkutsk to Chetah, thus establishing an easy connection between the interior of Siberia and the Pacific Ocean.

EUROPE.

Hofmann's Expedition to the Urals.—The first volume of Hofmann's scientific expedition to the Northern Ural and the Coast Mountains Pae Choi, in the years 1847–50, was published in 1853. The second volume of the same work has recently appeared. The following facts are gathered from it.*

The Ural maintains its northern direction, nearly coincident with the 59th meridian east of Greenwich, as far as 65° N. lat. Here it trends eastward, and at 67° 30′ N. lat. it touches the meridian 66° E. At this point rises conspicuously the peak of Pae-Jer, visible from Obdorsk. Thence the range resumes its former course from south to north, and at last terminates abruptly at 68° 32′ N. lat. and 66° 20′ E. long. in the Constantine peak on the Tundra, without reaching the sea. From it, separated by a plain forty-five versts broad, rises another mountain system, the Pae-Choi, which extends in a northwestern direction across the straights of Jugar to the island Waigatsch. The direction and external form of this mountain prove its independence, although it is not distinct from the Ural as regards the geologic era of its formation. The North Ural, despite its scant breadth, which in its greatest extent at Sabljä is but 75 versts, yet often suffers a separation into two or three parallel chains. In the north too are found the loftiest peaks of the whole range with perhaps the exception of the Konschakowsky peak near Bogoslowsk. The Töll-Poss and Sabljä exceed 5000 feet in height, the northern *Pae-Jer* reaches nearly the same height as do many peaks and even whole chains. We may take 3000 feet as the medium height of the peaks, but no peak penetrates the snow-line and consequently there is an entire absence of glaciers throughout the whole range. Its geognostic constitution

* Petermann, vol. iii, p. 270.

amid great individual diversities presents as a whole a remarkable uniformity. The Ural consists of metamorphic, talcose and chloritic schist, quartzite and granular limestone, which with a greater or less dip, run parallel to the axis of the range, and which are broken or uplifted at intervals by granite, syenite, serpentine, diorite, and porphyry. In relation to the forest line, it has been observed at 64° N. lat. it extends no higher than 1600 feet but at 65½° N. lat. that it ascends to 2000 feet. Farther towards the north the forest retreats from the summits of the range, though in the gorges clumps of larches are found, still, but no higher north than at the source of the Kara, above 67° N. lat. On the east side of the Ural the forest line running north is higher up than on the west side.

On the Tundra there are no species of wood found but dwarf-birches and willows, which flourish as far north as the sea of Kara. Many esculent fruits and plants are found in the more southerly parts of the North Ural. The fauna of this region is closely related to its vegetation.

Russian measurement of an Arc of Meridian.—From the year 1815 until 1855 the measurement of an arc of the meridian 25° 20′ long. E. from Paris was in progress between the mouth of the Danube and the Polar Sea. The work has been under the direction of Struve and Tenner of Russia, Selander of Sweden, and Hansteen of Norway, and in some respects it may be considered as the most important of all geodetic enterprises. It is now announced that the first two volumes, in quarto, pertaining to the survey, edited by M. Struve of Pulkova, and published by the Imperial Academy of Sciences in St. Petersburgh are almost ready to appear. Two editions, one in Russian and one in French, will be printed.

NORTH AMERICA.

Report of the United States Coast Survey for 1856.—1. The report of the Superintendent of the United States Coast Survey for 1856 has just been distributed. It contains, like the previous volumes, in addition to several important papers on Astronomy and Physics, a large amount of interesting geographical matter. Most of this is of too detailed and special a character to be here referred to, but the following facts are of general interest. Prof. Bache states that on the coast of the Atlantic Ocean and Gulf of Mexico, the work of the survey is more than half completed and the present rate of progress being more rapid than the former, he estimates that in ten or twelve years the field work will be essentially completed in all the sections but two. Forty-one plates have been completely engraved during the year, beside twenty-eight which have been in progress.

2. The chronometer expeditions for the determination of longitude begun in 1849, have been continued, but in the prospect of telegraphic communication between Europe and America are now to be suspended. The final longitude for these voyages is reported by Mr. G. P. Bond, as Cambridge, west of Greenwich $4^h\ 44^m\ 31{\cdot}89^s$, with a probable error of $0{\cdot}19^s$; or from Liverpool $4^h\ 32^m\ 31{\cdot}84^s$, with a probable error of $0{\cdot}19^s$. Prof. Bache remarks that after a careful comparison of this and former results he has come to the conclusion that the previous expeditions must be considered as mainly preparatory, their use having been in pointing out the errors to which the methods were liable, and in suggesting the proper means of eliminating them.

3. The survey of New York harbor, conducted at the request of the Commissioners on the Harbor Encroachments of New York is still in progress. Important results have been reached in respect to the well-established fact of the increase of Sandy Hook to the northward, thus narrowing the main ship-channel entrance. It is found that the deposit is caused by a slowly moving northwardly current on both sides of the Hook, running on the outer side more than seven hours out of the twelve, and on the inner, eleven hours out of the twelve, during both the ebb and flood tides, and meeting at the point of the Hook. The inner current is the one by which the flood and ebb tides draw, by the lateral communication of motion, the water from Sandy Hook bay, and the outer is similarly related to these tides as they pass False Hook channel. Within a century the Hook has increased a mile and a quarter, and at the rate of about one-sixteenth of a mile a year on the average for the last twelve years.

4. Dr. J. G. Kohl, a German traveler, for some time past resident in this country, has prepared for the Archives of the Coast Survey and submitted to the Superintendent, three distinct memoirs on the History of Explorations and Discoveries upon the Coast of the United States. The first relates to the Pacific, the second to the Gulf of Mexico, and the third to the Atlantic shores. Each memoir is in three parts,—Historical, Hydrographical and Bibliographical. A synopsis of the Memoir on the Pacific was given in the Report of the Coast Survey for 1855. Synopses of the other two are given in the report for 1856. It is proposed to publish the whole series as "Hydrographical Annals of the United States."

5. Lieut. E. B. Hunt makes a report on the progress of his index to articles in scientific journals, philosophical transactions, and works of a kindred character. This index will have particular reference to the wants of the Coast Survey, but the operations of that establishment bring under tribute so large a portion of the arena of physical science, that the volume will be of service to all who are interested in geodesy, geography, navi-

gation, hydrography and the various departments of physics. It will not be at all a reference index for separate treatises which must still be searched for in existing bibliographies. The value of this great work will be apparent to all investigators, and its early completion and publication are greatly to be desired.

6. A series of convenient tables for projecting maps of large extent, arranged by Assistant J. E. Hilgard, are published in Appendix No. 58. "They are based on a polyconic development of the earth's surface which supposes each parallel of latitude represented on a plane by the development of a cone having the parallel for its base, and its vertex in the point where a tangent to the parallel intersects the earth's axis. The degrees on the parallel preserve their true length and the general distortion of area is less than in any other mode of representing a given portion of the earth's surface."

"When the polyconic development is extended to the whole surface of the sphere a figure results which is represented on sketch No. 65 of the report. The distortion unavoidable in any representation of a spherical surface on a plane is here greatest in the equatorial regions near the eastern and western extremities of the map. The circumpolar regions are well represented, and it is believed that this projection will be found preferable to Mercator's for maps illustrating various points of physical geography, the only kind for which representations of the whole sphere are likely to be desirable."

Surveys in California for the Pacific Railroad.—Volumes 5 and 6 have just appeared of Reports of Pacific railroad surveys undertaken by the government of the United States. Vol. 5, contains a part of the results attained by the expedition which Lieut. R. S. Williamson commanded in 1853, the object of which was to determine routes in California to connect with the routes near the thirty-fifth and thirty-second parallels. The region explored lies chiefly west of the Colorado River and the crest of the Sierra Nevada. The first portion of the volume, by the commander, gives a general view of the country examined, having particular reference to the best course for a railroad. It is fully illustrated by tinted lithographs and wood cuts.

This is followed by a Report of Mr. William P. Blake on the geology, divided into two parts, (1.) an Itinerary, with general geological observations, and (2.) Particular observations upon portions of the route. Aside from the geology this report contains much that is new and valuable in respect to the geography of the region. A part of his observations on this journey were published by the author, Mr. Blake, in the Report of the U. S. Coast Survey for 1855, entitled, "Observations on the Physical Geography and Geology of the coast of California from Bodega Bay to San Diego."

The chapters most interesting in a geographical point of view, are the eleventh and seventeenth; of which the former is devoted to the orography and general features of relief of the middle and southern portions of California, and the latter to the characteristics of the Colorado desert.

Mr. Blake's views of the orography of the state are thus briefly stated. "That portion of the continent which lies within the limits of the state of California presents a greater variety in the relief of its surface and in its climate and vegetable productions than any other portion of equal area. The lofty chains of mountains, towering into the regions of perpetual snow, are perhaps not more striking and peculiar than the broad plain-like valleys which lie at their base and separate the principal ranges. The prominent orographic features are developed on a grand scale and with such simple relations that a conception of them is readily formed. The chief range, the Sierra Nevada, rises like a great wall of separation between the State and the elevated semi-desert region of the Great Basin and extends from the northern boundary as far south as the parallel of 35°. Parallel with this, and extending over a similar distance we find the Coast mountains, the two systems of ranges being separated by the broad plains of the Sacramento, San Joaquin and the Tulares, but uniting in latitude 35°, thus terminating the extended interior valleys of the south. South of the junction of the Sierra Nevada with the Coast Mts. there is but one prominent range, separating the coast slope from the Great Basin and the desert plains of the interior. Its direction is nearly transverse to the Sierra Nevada and Coast Mts., extending a few degrees south of east for more than 100 miles to the peak of San Bernardino. This is described in the notes as the Transverse Chain, the Bernardine Mts. or Bernardino Sierra. The peak of San Bernardino is separated from a high mountain south of it, San Gorgoño, by a considerable break or gap known as the pass of San Gorgoño or San Bernardino. From this pass southward the mountains form a continuous line throughout the peninsula of Lower California to its extremity at Cape St. Lucas. This line of elevation is described as the Peninsula Sierra. There are other less extended lines of elevation in the Great Basin and separates it from the Colorado river. Ranges are also found between the Peninsula Mts. and the Colorado, but all of these are only the southern extremities or prolongations of ranges, which reach their greatest development beyond the limits of the State. The principal mountains in this State may thus be described under five groups or divisions, the Sierra Nevada, Bernardino Nevada, Peninsula Sierra, Coast Mts. and Great Basin Mts."

The following account is given of the two principal valleys of the state. "The great valley between the Sierra Nevada and the Coast Mts. is traversed in its lowest portion by the Sacramento and San Joaquin rivers, which, flowing from the north and south, unite in the latitude of San Francisco and empty into the bay. It however extends farther south than the sources of the San Joaquin, its southern limits being determined by the union of the Sierra Nevada and the Coast Mts. under the parallel of 35°, and its northern limits extending beyond the parallel of 40° near to the head waters of the Sacramento, or over five degrees of latitude, a distance of more than 350 miles. Its average breadth south of the mouth of the American river in the Sacramento is about fifty-five miles; it being fifty miles at the mouth of the Sacramento and Joaquin, at the sources of the San Joaquin sixty miles, and across the Tulare lakes over sixty miles. Its whole area probably exceeds 15,000 square miles. The average elevation of these plains above the sea is not great."

"The valley of the Colorado desert is in many respects similar to the Tulare plains, but is more heated, arid and desert-like. It is properly the northern prolongation of the valley of the Gulf, reaching from its shores to the base of the San Bernardino. Its length to the head of the gulf is thus about 180 miles, and its average breadth about 50 miles, giving its area 9000 square miles. Its southern portion, or nearly half the area, is beyond the southern boundary of the State. The elevation of this valley is very slight and a portion of its surface is probably below the level of the sea. It is without any rivers and only one or two small streams reach its borders from the pass of San Bernardino and the Peninsula Sierra, and these are speedily absorbed in the sand or evaporated. The trend of the longer axis of the valley is nearly northwest and southeast, being parallel with the mountains on each side and coincident with the direction of the plains of the Sacramento and San Joaquin."

In referring to this new volume on the Pacific Railroad Surveys, we may mention a fact, which is stated in the December number of Petermann, p. 545. The draftsman of the expedition commanded by Lieut. Whipple, Herr Mollhausen, whose sketches of figures and landscapes illustrate vol. 2 of this great work, took home with him to Germany a large number of views and sketches which are now in the possession of the King of Prussia. These are about to be published in an elegant manner, by Mendelssohn in Leipsic, accompanied by Mollhausen's diary upon the journey, which will form a sort of commentary upon the drawings. This work will have considerable ethnographical value. Alexander von Humboldt has written a preface to it, in which he refers to the historic importance of the nations in New Mexico and the neighboring lands, because of their being on the course of the great migratory companies which under the name

of Tolteks, Chichimeks, Nahuatleks, and Azteks wandered, between the sixth and twelfth centuries, through southern tropical Mexico, partially peopling it. The work will consist of sixty or seventy sheets in quarto.

The sixth volume of the surveys is a report by Lieut. H. L. Abbot on the expedition originally commanded by Lieut. R. S. Williamson for determining a route for connecting the Sacramento Valley and Columbia river. The surveys were made in 1855–6. Of this volume, "Part I. contains the general report, divided into seven chapters; of which the first contains a general description of the different regions traversed during the survey. This synopsis has been prepared partly to enable those wishing merely to obtain a general idea of the country, to dispense with reading a mass of details, and partly to render the railroad report more intelligible. The second chapter is devoted entirely to a discussion of the facilities offered for the construction of a railroad near the lines of survey. The third, fourth and fifth chapters contain a narrative and itinerary of the expedition. An attempt has been made to give, in this portion of the report, a detailed description of the nature of the country examined; of the supply of wood, water, and grass near the trails; of the character of the Indian tribes; and of various other matters, interesting to those who wish to thoroughly understand the character of the regions explored. The sixth chapter contains a statement of the method used in computing altitudes from observations taken with the barometer. The seventh chapter contains an account of a former exploration of Lieut. Williamson, near a portion of our line of survey.

"Parts II, III, and IV, contain geological, botanical, and zoological reports upon the regions explored.

"The various appendices exhibit, in a tabular form, the astronomical and barometric observations, with the results deduced from them by computation.

"Two maps, constructed upon the polyconic projection, have been made to accompany this report. The first illustrates that portion of the survey which lay in California, and the second that in Oregon. The scale of each is one inch to twelve miles, or 1 : 760320. Two other illustrations of this report contain profiles of the most important portions of the routes travelled over by the surveying parties, and also of the most favorable railroad lines found in the vicinity of the trails. The horizontal scale of each profile is the same as that of the maps, being twelve miles to the inch, or 1 : 760320; the vertical scale is 1 : 15206·4. They are, therefore, distorted fifty times.

"The altitudes of the different stations were all determined by barometric observations."

Both of these volumes are issued in fine typographical style, and are handsomely illustrated. D. C. G.

Yale College Library, March 25, 1858.

T. XXVIII.—*Agassiz's Contributions to the Natural History of the United States.*

(Concluded from p. 216.)

)N the subject of classification, Professor Agassiz has thought foundly and brought out many original views. Regarding Author of nature as the author of the system of classifica- ı in nature, and believing that the various subdivisions stand ›rofound and orderly relations to one another, eminently be- ng kingdoms under a vast comprehensive plan, he has sought liscover the philosophical significance of these subdivisions— Branches, Classes, Orders, Families, Genera, Species—in or- that the terms may no longer be mere arbitrary symbols in nce, but expressions of exact and positive truths. Even if principles may require a fuller expansion and more precise nition to meet all the difficulties in this most difficult depart- ıt of science, Prof. Agassiz has the honor of pointing out the ıt way of thought and research and throwing light on the damental ideas in the grand system. Now that the subject begun to take shape under his labors, it will be compara- :ly easy for future science to mould this part or the other › that exact symmetry and truthfulness, which will be a per- expression of the plan in the kingdoms of life.

Vith regard to Classes, Orders, Families and Genera in classi- tion, Professor Agassiz holds as before stated, that they have eal although ideal existence, and that the groups are more : the separate stellar systems in the heavens, one above the ɜr in range or comprehensiveness, than like the larger and .ller branchings of a tree. The groups stand apart; and hey graduate into one another, as they often do, they still e their central type or cluster, and coalesce by their infe- , or what may be called marginal, species. Under such a v, we have an important test of the naturalness of subdi- ɔns in science. Reptiles do not approximate to Fishes ›ugh the higher families among the Fishes; nor Monkeys to nivora through the higher Carnivora; nor the Brachyural to Macroural Crustaceans through the typical Macrourans: approximations are through inferior species in each type. re are here no linear series any more than among the sys- s in space. Many exceptions to this rule will occur to natu- ɜts: and, still, it expresses a general truth with regard to the em of nature which cannot be overlooked without failing rely to appreciate that system.

/e enter now upon the views presented with relation to the use of the terms Branches, Classes, Orders, Families, Genera Species, and first cite a summary of the whole, from page :

"Upon the closest scrutiny of the subject, I find that these divisions cover all the categories of relationship which exist among animals, as far as their structure is concerned.

"*Branches* or *types* are characterized by the plan of their structure,

"*Classes*, by the manner in which that plan is executed, as far as ways and means are concerned,

"*Orders*, by the degrees of complication of that structure,

"*Families*, by their form, as far as determined by structure,

"*Genera*, by the details of the execution in special parts, and

"*Species*, by the relations of individuals to one another and to the world in which they live, as well as by the proportions of their parts, their ornamentation, etc.

"And yet there are other natural divisions which must be acknowledged in a natural zoölogical system; but these are not to be traced so uniformly in all classes as the former,—they are in reality only limitations of the other kinds of divisions."

1. *Branches.*—The Branches correspond to the ideal *plans* of structure in the Animal Kingdom, without any reference to the mode of expressing that plan in form or structure. They are the four Archetypes, recognized by Cuvier, the Radiate, Molluscan, Articulate, and the Vertebrate: the idea in the *first*, a radiate arrangement in the interior structure whatever that structure, the second and others having a bilateral symmetry; in the *second*, a jointless body or a simple sac; in the *third*, a jointed body, including a single cavity for the viscera and nerves; in the *fourth*, a vertebrate system with two longitudinal bone-sheathed cavities,—a neural cavity above and a visceral below.

In the course of his illustrations of the subject, Professor Agassiz says:

"As to the highest divisions of the animal kingdom, first introduced by Cuvier under the name of *embranchements*, (and which we may well render by the good old English word *branch*,) he tells us himself that they are founded upon distinct plans of structure, cast, as it were, into distinct moulds or forms. Now there can certainly be no reason why we should not all agree to designate as types or branches all such great divisions of the animal kingdom as are constituted upon a special plan,* if

* It is almost superfluous for me to mention here that the terms plan, ways and means, or manner in which a plan is carried out, complication of structure, form, details of structure, ultimate structure, relations of individuals, frequently used in the following pages, are taken in a somewhat different sense from their usual meaning, as is always necessary when new views are introduced in a science, and the adoption of old expressions, in a somewhat modified sense, is found preferable to framing new ones. I trust the value of the following discussion will be appreciated by its intrinsic merit, tested with a willingness to understand what has been my aim, and not altogether by the relative degree of precision and clearness with which I may have expressed myself, as it is almost impossible, in a first attempt of this kind, to seize at once upon the form best adapted to carry conviction. I wish also to be understood as expressing my views more immediately with reference to the animal kingdom, as I do not feel quite competent to extend the inquiry and the discussion to the vegetable kingdom, though I have occasionally alluded to it, as far as my information would permit.

we should find practically that such groups may be traced in nature. Those who may not see them may deny their existence; those who recognize them may vary in their estimation of their natural limits; but all can, for the greatest benefit of science, agree to call any group which seems to them to be founded upon a special plan of structure, a type or branch of the animal kingdom; and if there are still differences of opinion among naturalists respecting their limits, let the discussion upon this point be carried on with the understanding that types are to be characterized by different plans of structure, and not by special anatomical peculiarities. Let us avoid confounding the idea of plan with that of complication of structure, even though Cuvier himself has made this mistake here and there in his classification.

"The best evidence I can produce that the idea of distinct plans of structure is the true pivot upon which the natural limitation of the branches of the animal kingdom is ultimately to turn, lies in the fact that every great improvement, acknowledged by all as such, which these primary divisions have undergone, has consisted in the removal from among each, of such groups as had been placed with them from other considerations than those of a peculiar plan, or in consequence of a want of information respecting their true plan of structure. Let us examine this point within limits no longer controvertible. Neither Infusoria nor Intestinal Worms are any longer arranged by competent naturalists among Radiata. Why they have been removed, may be considered elsewhere; but it was certainly not because they were supposed to agree in the plan of their structure with the true Radiata, that Cuvier placed them in that division, but simply because he allowed himself to depart from his own principle, and to add another consideration, besides the plan of structure, as characteristic of Radiata,—the supposed absence of a nervous system, and the great simplicity of structure of these animals;—as if simplicity of execution had any necessary connection with the plan of structure. Another remarkable instance of the generally approved removal of a class from one of the types of Cuvier to another, was the transfer of the Cirripeds from among the Mollusks to the branch of Articulata. Imperfect knowledge of the plan of structure of these animals was here the cause of the mistake, which was corrected without any opposition, as soon as they became better known."—pp. 141, 142, 143.

2. *Classes.*—Under this head, Professor Agassiz remarks:

"Structure may be considered from many points of view: first, with reference to the plan adopted in framing it; secondly, with reference to the work to be done by it, and to the ways and means employed in building it up; thirdly, with reference to the degrees of perfection or complication which it exhibits, which may differ greatly, even though the plan be the same, and the ways and means employed in carrying out such a plan should not differ in the least; fourthly, with reference to the form of the whole structure and its parts, which bears no necessary relation, at all events no very close relation, to the degree of perfection of the structure, nor to the manner in which its plan is executed, nor to the plan itself, as a comparison between Bats and Birds, between Whales and Fishes, or between Holothurians and Worms, may easily show; fifthly

and lastly, with reference to its last finish, to the execution of the details in the individual parts.

"It would not be difficult to show, that the differences which exist among naturalists in their limitation of classes have arisen from an indiscriminate consideration of the structure of animals, in all these different points of view, and an equally indiscriminate application of the results obtained, to characterizing classes. Those who have not made a proper distinction between the plan of a structure and the manner in which that plan is actually executed, have either overlooked the importance of the great fundamental divisions of the animal kingdom, or they have unduly multiplied the number of these primary divisions, basing their distinctions upon purely anatomical considerations, that is to say, not upon differences in the character of the general plan of structure, but upon the material development of that plan. Those, again, who have confounded the complication of the structure with the ways and means by which life is maintained through any given combination of systems of organs, have failed in establishing a proper difference between class and ordinal characters, and have again and again raised orders to the rank of classes. For we shall see presently, that natural orders must be based upon the different degrees of complication of structure, exhibited within the limits of the classes, while the classes themselves are characterized by the manner in which the plan of the type is carried out, that is to say, by the various combinations of the systems of organs constituting the body of the representatives of any of the great types of the animal kingdom; or perhaps, still more distinctly, the classes are characterized by the different ways in which life is maintained, and the different means employed in establishing these ways."—pp. 145, 146.

An illustration next follows from among the Radiates. The Polyps and Acalephs constitute two *Classes*, differing not in the complication of their structure, but in the manner in which the Radiate plan is carried out. The same is true for the Worms, Crustaceans and Insects, the three classes of Articulates; for Mammals, Birds, etc., among Vertebrates.

3. *Orders.*—In no department of classification is there greater diversity of opinion among naturalists, than in that relating to the subdivisions termed orders. The following paragraphs are from the section on this subject.

"To find out the natural characters of orders from that which really exists in nature, I have considered attentively the different systems of Zoölogy in which orders are admitted and apparently considered with more care than elsewhere, and in particular the *Systema Naturæ* of Linnæus, who first introduced in Zoölogy that kind of groups, and the works of Cuvier, in which orders are frequently characterized with unusual precision, and it has appeared to me that the leading idea prevailing everywhere respecting orders, where these groups are not admitted at random, is that of a definite rank among them, the desire to determine the relative standing of these divisions, to ascertain their relative superiority or inferiority, as the name order, adopted to designate them, actually implies. The first order in the first class of the animal kingdom, accord-

ing to the classification of Linnæus, is called by him *Primates*, expressing, no doubt, his conviction that these beings, among which Man is included, rank uppermost in their class. Blainville uses here and there the expression of "degrees of organization," to designate orders. It is true Lamarck uses the same expression to designate classes. We find, therefore, here as everywhere, the same vagueness in the definition of the different kinds of groups adopted in our systems. But if we would give up any arbitrary use of these terms, and assign to them a definite scientific meaning, it seems to me most natural, and in accordance with the practice of the most successful investigators of the animal kingdom, to call orders such divisions as are characterized by different degrees of complication of their structure, within the limits of the classes. As such I would consider, for instance, the Actinoids and Halcyonoids in the class of Polypi, as circumscribed by Dana; the Hydroids, the Discophoræ, and the Ctenoids among Acalephs; the Crinoids, Asterioids, Echinoids, and Holothuriæ among Echinoderms; the Bryozoa, Brachiopods, Tunicata, Lamellibranchiata among Acephala; the Branchifera and Pulmonata among Gasteropods; the Ophidians, the Saurians, and the Chelonians among Reptiles; the Ichthyoids and the Anoura among Amphibians, etc." * * * *

"From the preceding remarks respecting orders it might be inferred that I deny all gradation among all other groups, or that I assume that orders constitute necessarily one simple series in each class. Far from asserting any such thing, I hold on the contrary, that neither is necessarily the case. But to explain fully my views upon this point, I must introduce here some other considerations. It will be obvious, from what has already been said, (and the further illustration of this subject will only go to show to what extent this is true,) that there exists an unquestionable hierarchy between the different kinds of groups admitted in our systems, based upon the different kinds of relationship observed among animals, that branches are the most comprehensive divisions, including each several classes, that orders are subdivisions of the classes, families subdivisions of orders, genera subdivisions of families, and species subdivisions of the genera: but not in the sense that each type should necessarily include the same number of classes, nor even necessarily several classes, as this must depend upon the manner in which the type is carried out. A class, again, might contain no orders, if its representatives presented no different degrees characterized by the greater or less complication of their structure; or it may contain many, or few, as these gradations are more or less numerous and well marked; but as the representatives of any and every class have of necessity a definite form, each class must contain at least one family, or many families, indeed, as many as there are systems of forms under which its representatives may be combined, if form can be shown to be characteristic of families. The same is the case with genera and species; and nothing is more remote from the truth than the idea that a genus is better defined in proportion as it contains a greater number of species, or that it may be necessary to know several species of a genus before its existence can be fully ascertained. A genus may be more satisfactorily characterized, its peculiarity more fully ascertained, its limits better defined, when we know all its represen-

tatives; but I am satisfied that any natural genus may be at least pointed out, however numerous its species may be, from the examination of any single one of them. Moreover, the number of genera, both in the animal and vegetable kingdom, which contain but a single species, is so great that it is a matter of necessity in all these cases to ascertain their generic characteristics from that one species. Again, such species require to be characterized with as much precision, and their specific characters to be described with as much minuteness, as if a host of them, but not yet known, existed besides. It is a very objectionable practice among zoölogists and botanists, to remain satisfied in such cases with characterizing the genus, and perhaps to believe, what some writers have actually stated distinctly, that in such cases generic and specific characters are identical."—pp. 151–153.

4. *Families.*—Professor Agassiz, in his section on Families, explains at length that *form* is not the characteristic at the basis of Classes, Orders, or Genera. He shows that the Classes and Orders embrace a great diversity of form, as those of Bats and Whales for example among Mammals, of Sharks and Eels among Fishes, of Lobsters and Barnacles among Crustacea, of Butterflies and Beetles among Insects, and so on. Again, form is not the fundamental characteristic of Genera; for in related genera there is little distinction of this nature. He asks:

"Do, for instance, the genera of Ursina, the Bears, the Badgers, the Wolverines, the Raccoons, differ in form? Do the Phocoidæ, the Delphinoidæ, the Falconinæ, the Turdinæ, the Fringillinæ, the Picinæ, the Scolopacinæ, the Chelonioidæ, the Geckonina, the Colubrina, the Sparoidæ, the Elateridæ, the Pyralidoidæ, the Echinoidæ, etc., differ any more among themselves? Certainly not; though to some extent, there are differences in the form of the representatives of one genus when compared to those of another genus; but when rightly considered, these differences appear only as modifications of the same type of forms. Just as there are more or less elongated ellipses, so do we find the figure of the Badgers somewhat more contracted than that of either the Bears, or the Raccoons, or the Wolverines, that of the Wolverines somewhat more elongated than that of the Raccoons; but the form is here as completely typical as it is among the Viverrina or among the Canina, or among the Bradypodidæ, or among the Delphinoidæ, etc. We must therefore exclude form from the characteristics of natural genera, or at least introduce it only as a modification of the typical form of natural families."—p. 157.

Form is then laid down as the character at the basis of the Family groups.

"Unless, then, form be too vague an element to characterize any kind of natural groups in the animal kingdom, it must constitute a prominent feature of families. I have already remarked, that orders and families are the groups upon which zoölogists are least agreed, and to the study and characterizing of which they have paid least attention. Does this not arise simply from the fact, that, on the one hand, the difference between ordinal and class characters has not been understood, and only as-

sumed to be a difference of degree; and, on the other hand, that the importance of the form, as the prominent character of families, has been entirely overlooked? For, though so few natural families of animals are well characterized, or characterized at all, we cannot open a modern treatise upon any class of animals without finding the genera more or less naturally grouped together, under the heading of a generic name with a termination in *idæ* or *inæ* indicating family and sub-family distinctions; and most of these groups, however unequal in absolute value, are really natural groups, though far from designating always natural families, being as often orders or sub-orders, as families or sub-families. Yet they indicate the facility there is, almost without study, to point out the intermediate natural groups between the classes and the genera. This arises, in my opinion, from the fact, that family resemblance in the animal kingdom is most strikingly expressed in the general form, and that form is an element which falls most easily under our perception, even when the observation is made superficially. But, at the same time, form is most difficult to describe accurately, and hence the imperfection of most of our family characteristics, and the constant substitution for such characters of features which are not essential to the family. To prove the correctness of this view, I would only appeal to the experience of every naturalist. When we see new animals, does not the first glance, that is, the first impression made upon us by their form, give us at once a very correct idea of their nearest relationship? We perceive, before examining any structural character, whether a Beetle is a Carabicine, a Longicorn, an Elaterid, a Curculionid, a Chrysomeline; whether a Moth is a Noctuelite, a Geometrid, a Pyralid, etc.; whether a bird is a Dove, a Swallow, a Humming-bird, a Woodpecker, a Snipe, a Heron, etc., etc. But before we can ascertain its genus, we have to study the structure of some characteristic parts; before we can combine families into natural groups, we have to make a thorough investigation of their whole structure, and compare it with that of other families. So form is characteristic of families; and I can add, from a careful investigation of the subject for several years past, during which I have reviewed the whole animal kingdom with reference to this and other topics connected with classification, that form is the essential characteristic of families. I do not mean the mere outline, but form as determined by structure; that is to say, that families cannot be well defined, nor circumscribed within their natural limits, without a thorough investigation of all those features of the internal structure which combine to determine the form."—pp. 159, 160.

5. *Genera.*—The relations of Genera to the other grades of subdivisions are thus presented on pages 162, 163:

"I have stated before, that in order to ascertain upon what the different groups adopted in our systems are founded, I consulted the works of such writers as are celebrated in the annals of science for having characterized with particular felicity any one kind of these groups, and I have mentioned Latreille as prominent among zoölogists for the precision with which he has defined the genera of Crustacea and Insects, upon which he has written the most extensive work extant. An anecdote which I have often heard repeated by entomologists who knew Latreille well, is

very characteristic as to the meaning he connected with the idea of genera. At the time he was preparing the work just mentioned, he lost no opportunity of obtaining specimens, the better to ascertain from nature the generic peculiarities of these animals, and he used to apply to the entomologists for contributions to his collection. It was not show specimens he cared to obtain, any would do, for he used to say he wanted them only 'to examine their parts.' Have we not here a hint, from a master, to teach us what genera are and how they should be characterized? Is it not the special structure of some part or other, which characterizes genera? Is it not the finish of the organization of the body, as worked out in the ultimate details of structure, which distinguishes one genus from another? Latreille, in expressing the want he felt with reference to the study of genera, has given us the key-note of their harmonious relations to one another. Genera are most closely allied groups of animals, differing neither in form, nor in complication of structure, but simply in the ultimate structural peculiarities of some of their parts; and this is, I believe, the best definition which can be given of genera. They are not characterized by modifications of the features of the families, for we have seen that the prominent trait of family difference is to be found in a typical form; and genera of the same family may not differ at all in form. Nor are genera merely a more comprehensive mould than the species, embracing a wide range of characteristics; for species in a natural genus should not present any structural differences, but only such as express the most special relations of their representatives to the surrounding world and to each other. Genera, in one word, are natural groups of a peculiar kind, and their special distinction rests upon the ultimate details of their structure."—pp. 162, 163.

6. *Species.*—Many topics are suggested in the section on Species. Professor Agassiz commences by denying that there is "an unfailing criterion of specific identity" in the laws of the sexes or hybridity, stating that the idea "is a complete fallacy, or at least a *petitio principii*, not admissible in a philosophical discussion of what truly constitutes the characteristics of species." But surely an assumption either side is, one as much as the other, a *petitio principii*. The subject is one for investigation, and in which direct study of the actual intercourse of admitted distinct species is but barely begun; science is far from a conclusion based on well established natural history facts. In an article entitled "Thoughts on Species," published in the number of this Journal for last November, we have appealed to general science for evidence on this point; and all nature has seemed to respond to the idea of permanence, against destructive hybridity. Professor Agassiz would urge that the limits of hybridity are sometimes too indefinite to allow of the safe use of this criterion with regard to species. We should claim that this is the point to be investigated; that the limit is so obviously distinct to present knowledge in the great majority of cases, and so essential to the existence of the kingdoms of nature, that its indefiniteness in any case requires special and cogent demonstration.

We would add, that the great question whether man is of one species cannot in our view be decided adversely by science, until the limits of variation and laws of variation in zoological species are far better understood than at the present time; not until we know why it is that so many species, and in some groups all the species of those groups, vary little, while others undergo such diversities that naturalists have sometimes made a number of species and even genera out of a single species before the truth that there was but one among them was finally known—showing that the variations in one species may be equal to species- or genus-differences in others; and farther, not until we comprehend more thoroughly than now the causes that are operating to exterminate the weaker and more degraded races of men. Our ignorance of adequate *causes* of variation is an ever present argument with many on this subject: but as long as there are ascertained varieties or abnormities, the origin of which we cannot explain, the argument is as much against these as the others, and, plainly, therefore, has no force against either. As suggested in the article referred to, we believe that the evidence which science will hereafter furnish will strengthen the proof that man is (1) of one species, (2) of one birthland, and (3) of one original variety. The question (4) as to one first family under that one variety, it may not be so able in itself alone to meet. One of the most prominent arguments against unity,—that from our ideas of incestuous connections,—touches only this last point. Professor Agassiz, it should be said, enters into no discussion of this subject in his volumes, and rather implies than expresses the views which he has elsewhere presented at some length. The main principles above referred to as lying at the basis of this discussion—both the actual permanence of species and the necessity of studying out the limits of variations,—he fully sustains. The question of the plurality of parentage or of species for the human race, he has rightly regarded as coming within the admitted range of zoological investigation, and demanding the most careful research. While expressing his opinion freely on the side of plurality, at least, of parentage, he leaves the subject in his publications still an open one.

Upon the nature of individuals and species, he observes,—first speaking of individuals:

"No one nor all of them represent fully, at any particular time, their species; they are always only the temporary representatives of the species, inasmuch as each species exists longer in nature than any of its individuals. All the individuals of any or of all species now existing are only the successors of other individuals which have gone before, and the predecessors of the next generations; they do not constitute the species, they represent it. The species is an ideal entity, as much as the genus, the family, the order, the class, or the type; it continues to exist, while

its representatives die, generation after generation. But these representatives do not simply represent what is specific in the individual, they exhibit and reproduce in the same manner, generation after generation, all that is generic in them, all that characterizes the family, the order, the class, the branch, with the same fullness, the same constancy, the same precision. Species then exist in nature in the same manner as any other groups; they are quite as ideal in their mode of existence as genera, families, etc., or quite as real. But individuals truly exist in a different way; no one of them exhibits at one time all the characteristics of the species, even though it be hermaphrodite, neither do any two represent it, even though the species be not polymorphous, for individuals have a growth, a youth, a mature age, an old age, and are bound to some limited home during their lifetime. It is true, species are also limited in their existence; but for our purpose, we can consider these limits as boundless, inasmuch as we have no means of fixing their duration, either for the past geological ages, or for the present period, whilst the short cycles of the life of individuals are easily measurable quantities. Now as truly as individuals while they exist represent their species for the time being, and do not constitute them, so truly do these same individuals represent at the same time their genus, their family, their order, their class, and their type, the characters of which they bear as indelibly as those of the species.

"*As representatives of Species*, individual animals bear the closest relations to one another; they exhibit definite relations also to the surrounding elements, and their existence is limited within a definite period.

"*As representatives of Genera*, these same individuals have a definite and specific ultimate structure, identical with that of the representatives of other species.

"*As representatives of Families*, these same individuals have a definite figure, exhibiting, with similar forms of other genera, or for themselves, if the family contains but one genus, a distinct specific pattern.

"*As representatives of Orders*, these same individuals stand in a definite rank when compared to the representatives of other families.

"*As representatives of Classes*, these same individuals exhibit the plan of structure of their respective type in a special manner, carried out with special means and in special ways.

"*As representatives of Branches*, these same individuals are all organized upon a distinct plan, differing from the plan of other types.

"Individuals then are the bearers, for the time being, not only of specific characteristics, but of all the natural features in which animal life is displayed in all its diversity.

"Viewing individuals in this light, they resume all their dignity; they are no longer absorbed in the species to be for ever its representatives, without ever being any thing for themselves. On the contrary it becomes plain, from this point of view, that the individual is the worthy bearer, for the time being, of all the riches of nature's wealth of life. This view further teaches us how we may investigate, not only the species in the individual, but the genus also, the family, the order, the class, the type, as indeed naturalists have at all times proved in practice, whilst denying the possibility of it in theory.

"Having thus cleared the field of what does not belong therein, it now remains for me to show what in reality constitutes species, and how they may be distinguished with precision within their natural limits.

"If we would not exclude from the characteristics of species any feature which is essential to it, nor force into it any one which is not so, we must first acknowledge that it is one of the characters of species to belong to a given period in the history of our globe, and to hold definite relations to the physical conditions then prevailing, and to animals and plants then existing. These relations are manifold, and are exhibited: 1st, in the geographical range natural to any species, as well as in its capability of being acclimated in countries where it is not primitively found; 2d, in the connection in which they stand to the elements around them, when they inhabit either the water, or the land, deep seas, brooks, rivers and lakes, shoals, flat, sandy, muddy, or rocky coasts, limestone banks, coral reefs, swamps, meadows, fields, dry lands, salt deserts, sandy deserts, moist land, forests, shady groves, sunny hills, low regions, plains, prairies, high table-lands, mountain peaks, or the frozen barrens of the Arctics, etc.; 3d, in their dependence upon this or that kind of food for their sustenance; 4th, in the duration of their life; 5th, in the mode of their association with one another, whether living in flocks, small companies, or isolated; 6th, in the period of their reproduction; 7th, in the changes they undergo during their growth, and the periodicity of these changes in their metamorphosis; 8th, in their association with other beings, which is more or less close, as it may only lead to a constant association in some, whilst in others it amounts to parasitism; 9th, specific characteristics are further exhibited in the size animals attain, in the proportions of their parts to one another, in their ornamentation, etc., and all the variations to which they are liable.

"As soon as all the facts bearing upon these different points have been fully ascertained, there can remain no doubt respecting the natural limitation of species; and it is only the insatiable desire of describing new species from insufficient data which has led to the introduction in our systems of so many doubtful species, which add nothing to our real knowledge, and only go to swell the nomenclature of animals and plants already so intricate.

"Assuming then, that species cannot always be identified at first sight, that it may require a long time and patient investigations to ascertain their natural limits; assuming further, that the features alluded to above are among the most prominent characteristics of species, we may say, that species are based upon well determined relations of individuals to the world around them, to their kindred, and upon the proportions and relations of their parts to one another, as well as upon their ornamentation. Well digested descriptions of species ought, therefore, to be comparative; they ought to assume the character of biographies, and attempt to trace the origin and follow the development of a species during its whole existence. Moreover, all the changes which species may undergo in course of time, especially under the fostering care of man, in the state of domesticity and cultivation, belong to the history of the species; even the anomalies and diseases to which they are subject, belong to their cycle, as well as their natural variations. Among some species, variation of color is frequent,—others never change,—some change periodically,—others accidentally; some throw off certain ornamental appendages at regular times,—the Deers their horns,—some Birds the ornamental plumage they

wear in the breeding season, etc. All this should be ascertained for each, and no species can be considered as well defined and satisfactorily characterized, the whole history of which is not completed to the extent alluded to above."—pp. 167–169.

In the citation on page 322, it will be observed that other subdivisions in classification are here recognized, namely, *subclasses*, *suborders*, *subfamilies*, *subgenera*, subordinate to those already mentioned; that of a subclass being based on a character like that characterizing a class, but of less comprehensive character; and that of a suborder on ordinal characters: and so on. Respecting them we cite a single paragraph:

"These distinctions have long ago been introduced into our systems, and every practical naturalist, who has made a special study of any class of the animal kingdom, must have been impressed with the propriety of acknowledging a large number of subdivisions, to express all the various degrees of affinity of the different members of any higher natural group. Now, while I maintain that the branches, the classes, the orders, the families, the genera, and the species are groups established in nature respectively upon different categories, and while I feel prepared to trace the natural limits of these groups by the characteristic features upon which they are founded, I must confess at the same time that I have not yet been able to discover the principle which obtains in the limitation of their respective subdivisions. All I can say is, that all the different categories considered above, upon which branches, classes, orders, families, genera, and species are founded, have their degrees, and upon these degrees sub-classes, sub-orders, sub-families, and sub-genera have been established. For the present, these subdivisions must be left to arbitrary estimations, and we shall have to deal with them as well as we can, as long as the principles which regulate these degrees in the different kinds of groups are not ascertained. I hope, nevertheless, that such arbitrary estimations are for ever removed from our science, as far as the categories themselves are concerned."—p. 171.

The citations which have been made are unavoidably an imperfect presentation of the subject of classification as developed by Prof. Agassiz, and we must refer our readers to his own words for full explanations. Many, while admiring the clear-sighted vision which has perceived, in the midst of so much detail in nature and so much confusion in science, the great ideas brought out, will find difficulties in applying the scheme. We feel them ourselves, and shall need to give the system a more thorough study, before we can fully appreciate all the bearings of the principles. Professor Agassiz acknowledges his own embarrassment in adapting them to the Vegetable Kingdom. We enter therefore into no proper discussion of the whole subject, and only throw out a few thoughts by way of suggestion, or to elicit further explanations. As Prof. Agassiz has stated, the truthfulness of the system of ideas, and the correctness of any particu-

lar application of them, are two distinct questions; and if the former be established, discussion becomes restricted to the latter.

While perceiving that science has here derived views respecting Branches, Classes, and the other subdivisions, which will contribute much to her progress, and also believing that independent types of structure (using this word in its most general sense) are the true basis for the subdivisions which are to be coördinated into system, or rather to be recognized in their natural coördinate and subordinate relations, we are still led to inquire—

Whether the number of primal subdivisions is necessarily in all departments of life only those stated? whether the number of primal subdivisions between Order and Genus is in all cases but one, all others being subordinate to Order and Family? In what sense the idea of rank, made characteristic of the Orders, differs from the all-pervading idea, which reaches from the Branches downward, until it fades out because we cannot longer distinguish what are marks of higher or lower grade,—the four Branches (the Vertebrate, Articulate, Molluscan and Radiate,) having a distinct ordinal relation among themselves; so the Classes under these branches (as Insects, Crustacea and Worms in the Articulate); so the Orders, the same; and so also any subdivisions under Orders, (see beyond,) even in some cases to Families and Genera? Whether the ordinal characteristics may not fail to be distinguishable, for want of marks of rank or grade that we can now understand, even in divisions as high as Orders, and whether it is not for this reason, in part, that the system is not so easily applicable to the Vegetable Kingdom in which the criteria of grade are not fully made out? Whether the idea of order or rank is not in fact so universal in the system as to make it an unsatisfactory definition of any one grade of subdivisions, except under other restrictions than those mentioned? Whether the facility with which we mark off distinctions of grade or ordinal relations in subdivisions under the different classes of animals does not depend in some degree on the extreme difference of grade between the highest and lowest species,—multitudes of species within narrow limits being on this ground, less easily divided off into grades than if distributed between wide extremes, and especially if, at the same time few in number? Whether, when we leave the grand level upon which the species of an Order or group have been mostly developed, and trace out the degraded forms of the same group, we do not generally find difference of rank coming out prominently to view, and so proving that some actual difference exists among the multitudes, even when not to be detected by any known methods? Whether one of the grand subdivisions of a Class, or an Order, etc., does not often stand apart, as an expression of a new or intruded idea, not involved in either of the other grand

subdivisions, and often coming less distinctly into ordinal relations with them? Whether, while ordinal distinctions fade out as we descend from Branches to Families, *form* does not, conversely, rise in defined value,—being an element even in the idea of the Branches; and in the succeeding divisions becoming increasingly appreciable, each in succession having a more and more narrowed system of variants; and whether it is not as a member in this series, that the Family (a grade of subdivision based on those variations of the essential parts or material of the structure out of which form proceeds, and not on profounder differences,) has the family likeness marked in external form, as Agassiz claims? And also, whether, in connection with general form, it does not happen that the form or structure of organs, besides being an additional expression of the same idea, sometimes requires the dividing off of a family group, when external form would not seem to demand it?

We throw out these queries without attempting to give them a formal answer. We do not imply any doubt as to the truthfulness of the grand idea laid down for the Branches, or of that for the Classes, or of the importance of ordinal relations, or of form, as characteristic of the Family group, or of superficial structural details as the basis of Genera. Instead of attributing less importance to these ideas we are led by the views themselves, from which we have derived profound instruction, to suspect even a more comprehensive meaning and use of them than has been presented. The idea of ordinal relations seems to rise every where, in the divisions above Orders, as well as below; and with diminishing distinctness as we go downward in the scale of subdivisions; so as to suggest the consideration, why Classes are not Orders under the Branches; and why the first range of Orders under Classes should be a primal division and not the second range, and so for others. So again with regard to Form: it is an ideal element even as regards a species, since with each there is a range of variations more or less wide. But the range in species is extremely small, compared with the range in Classes: and with each step downward, it is becoming less and less of a mathematical abstraction, and therefore more easily cognizable by the mind. The variations in the higher subdivisions embrace the existence and non-existence of fundamental parts; but as we descend, we come to a range in which these are constant, and then the variation is in the relations of the parts; at this grade of subdivisions then, *form* may be of that kind which strikes the mind of one but little accustomed to see generalities, and this is most prominently the Family grade, although it may be one of higher degree. If then we give to ordinal relations and form this comprehensive bearing we are only exalting their importance. We hold all the more strongly the view that

ideal plan, structural type, order or rank, form, and diversity of details and adaptations, are "all the categories of relationship which exist among animals, as far as their structure is concerned."

There is a freedom in nature in the use of form, structure and differences of grade in her systems of groups, which teaches that all general principles of classification should be liberally interpreted, and not be allowed to become rigid and thereby artificial. Moreover, under this freedom, we find so much diversity in the value of the same organs among different groups,—one group, for example, exalting certain characteristics that are valueless in others,—that we are compelled to allow each, for itself, to be in a sense its own interpreter. These facts make it the more difficult to give general principles that comprehensive form of expression which shall not encounter objections; and at the same time they enhance the difficulty of applying those principles when once brought out to view. It is especially essential to have in mind, as a foundation for correct judgment on these topics, this one truth of comprehensive bearing, which has been already referred to, that natural groups are based on distinct types, or are expressions of distinct purposes or ideas in nature; and that only groups of this kind—and not those made by reference to some special organ in the structure—can be satisfactorily compared with one another in the determination of ordinal relations; also, that while a type may run down into degraded forms, mere degradation is not a reason for breaking the group in two, an upper and a lower portion; and that types of very unequal rank may descend in their lowest species nearly to a common level.

A brief reference to the class of Crustacea, which has been our special study, will serve for a few illustrations. This class, although not one of the most prominent in the Animal Kingdom is one of the best for the study of general principles of classification, because of its great diversities of grade. The spiral arrangement of vegetation is but faintly distinguished in flowers, and the mathematical law would not have been learned at all were it not for the leaves, which show us the spiral drawn out long. The class of Crustacea is somewhat analogous in being a class drawn out long. It reaches in one direction to the memberless animalcule (the Rotifer), and in the other to the Lobster and Crab:—and in cubic dimensions its members vary from a ten-millionth of an inch to 200 inches, or in ratio from 1:2,000,000,000, at least 1,000 times greater than that for Insects; and while the extremes are thus widely separate, the whole range from one limit to the other is occupied by a number of species not exceeding one-fiftieth of those of Insects. There is reason, therefore, for expecting a magnified display of principles.

a. In this Class, with so vast a range, we necessarily find the ordinal character of the Orders well exhibited—the orders *Decapoda*, *Tetradecapoda*, *Entomostraca* and *Rotifera*, being well defined types, distinct in grade. The Articulate Branch of the Animal Kingdom was established through the institution of the type-structures of Insects, Crustacea and Worms; and the Crustacean type of structure was to have a range from the animalcular grade to the Crab and Lobster. This result has been accomplished, not by modifications of *one* subordinate type, for no one admits of being made efficient through so wide a range; but by four types of structure each corresponding to a separate grade of quality and range of size,—the normal size of the Decapods greatest, of the Tetradecapods next, of the Entomostracans next, and of the Rotifers least. The large size found among some Entomostracans may be regarded as vegetative expansion beyond the normal size. A type of structure of inferior grade may admit of a great amount of enlargement, while one of superior grade could not undergo corresponding diminution. The enlargement in the former is rather evidence of degradation than elevation; it is not making the least approximation to that elevation which belongs normally to the higher and larger type.

Agassiz's ordinal relations are thus admirably exhibited by the Orders. An example of the value of his views is seen in their having led him to the right step in arranging under the head of Entomostraca the Cirripeds, of which the writer had made a distinct Order. In ordinal value they belong with the Entomostracans.

Three of the Orders, the Decapod, Entomostracan, and Rotifer, appear to be types in a common series. But the Tetradecapods are out of the range, on an independent plan of structure. Still, the type may be considered as linked to the other series through the composite type of Palæozoic time, the Trilobites, if we are right in the position we give this ancient group of Crustaceans.

b. We now look a step lower, and consider the types or subdivisions under one of these Orders, the Order Decapoda. The subdivisions of the Decapods are *three*—(1) The *Brachyurans* (Crabs), (2) the *Macrourans* (Shrimps and Lobsters), and (3) the *Squilloids*. Among these groups ordinal relations are strikingly apparent, as much so, indeed, as in the case of the Orders; the Macrourans are obviously below the Brachyurans, and the Squilloids, below the Macrourans. But while the types were made to correspond to separate grades, there was little reference in their institution to a separate range of size; it is a difference of grade within nearly the same range of size; and it is dependent fundamentally on different grades of anterior concentration in the life energies of the animal, or of cephalization (or thoraco-cephalization) in the system,—a principle alluded to on p. 213 of our last

mber, and exemplified, in a general way, in the shortening of
body posteriorly and the compacting anteriorly which accom-
ies elevation of grade.*

The lowest of these groups, the Squilloid, stands somewhat
rt from the others like a distinct idea, intruded on the type.
e Brachyurans and Macrourans belong to a common typical
e and are separate expansions in that line; the series however
not a continuous one, for the groups approximate only through
degradations of the former, these degradations appearing in a
mber of genera which make up the so-called *Anomoura.* This
t indicates the independence of the types. This independence
arther sustained by the fact that the Anomoura were the char-
eristic Crustacea of the Secondary age preceding mostly the
achyura and typical Macroura. The Anomoura are an em-
onic prolongation downward of the Brachyural type; and the
sis group (Schizopoda) consists of still inferior embryonic
ms of mainly the Macroural line.

Looking, again, a step lower, at subdivisions under the
achyural type, we find *four,* well defined: the Maioids, the
ncroids (and Grapsoids), the Corystoids, and the Leucosoids.
om the Maioids to the Corystoids the ordinal relation is very
dent, the Maioids or Triangular Crabs standing obviously at
head. But, as in the preceding, there is little reference in
types to a different range of size, while there is a reference
anterior concentration or an increased cephalization of the
tem.

The organs and structure are essentially the same in the
ioids, Cancroids and Corystoids. But the Leucosoids (embra-
g the genera Leucosia, Iphis, Ixa, Ebalia, &c.,) are a side type;

* The marks of grade in these and other Crustacea are discussed in the writer's
l. Exp. Report on Crustacea, and also briefly in this Journal, vol. xxii, p. 14. We
ive a good illustration of this difference of cephalothoracic concentration in the
tions of the Brachyurans, Macrourans and Squilloids. The body consists in
stacea of the two parts, abdomen and cephalothorax. In the Squilla group, the
est of the three, the abdomen is two to three times larger than the cephalotho-
; the energies of the animal are used to an extreme extent in making its hinder
s; and the front are loosely put together, the eyes and two pairs of antennæ
g on separate segments; and besides, the posterior part of the cephalothorax is
thened out into a series of distinct segments like the abdomen. Moreover the
omen carries the liver and ovaries; and the Squilloids therefore are eminently
trourans. In the Macrouran type, the abdomen is in weight about equal to the
halothorax, or smaller, and the whole cephalothorax is gathered compactly
eath the carapax. In the Brachyuran type, the abdomen is not over one-fiftieth
weight of the cephalothorax, and nearly all the energies of life are employed
naking the cephalothorax and exalting the head organs. Thus in each step
ard, a large share of the force of the being is thrown forward to the exaltation
he cephalic portion of the body. The three types are constructed in accordance
this distinction. And it is a potential and mathematical distinction; for each
nal is a kind of life-engine, and the three types are three grades in the life-
ne structure, differing in the quality or degree of the force; each has a typical
e, and a range of variations upon this value according with variations of structure.

that is, they embrace a distinct idea engrafted on the ordinary Brachyural type:—their rank is probably between that of the Maioids and Cancroids.

Among the Macrourans, also, there are four types, the Astacoids (including Scyllarus, Palinurus, Astacus), the Caridoids (including Palæmon, etc.), the Penæoids, and the Callianassoids, and they are parallel with the four subdivisions of the Brachyurans. From the Astacoids to the Penæoids, ordinal relations are exceedingly distinct; the three types depend on three systems of modifications of one general plan of structure, and, like the above, rest, as we have elsewhere shown, on different grades of cephalization. The Callianassa group is out of the line, an intrusive or aberrant group like the Leucosoids in the Brachyura. In mean or average grade the species may rank with the Caridoids; but the range of grade among them is large. They have some relations to the Squilloids—the aberrant Order among the Decapods.*

There are thus in Crustacea,

First, a range of Orders, based on independent types, in which range of size as well as grade of quality is a fundamental idea.

Second, another ordinal range, based on grades of anterior concentration in the structure, and affecting the structure of the body as a whole, the cephalothorax and abdomen.

Third, a third ordinal range, also based on grades of anterior concentration, but affecting the cephalothorax mainly, and leading to the highest degree of cephalization.

* The subdivisions of Crustacea which have been mentioned, are the following: The grouping differs somewhat from that given in the writer's Report on Crustacea.

CRUSTACEA.

Order I. DECAPODS.

ORDERS OF 2D GRADE,

I. BRACHYURANS.

Orders of 3d grade,

1. Maioids.
2. Cancroids and Grapsoids.
3. Corystoids.
4. Leucosoids. *Aberrant.*

Appendix. Anomoura—*Embryonic in type.*

II. MACROURANS.

1. Astacoids.
2. Caridoids.
3. Penæoids.
4. Callianassoids. *Aberrant.*

Appendix. Schizopods—*Embryonic in type.*

III. GASTROURANS OR SQUILLOIDS.

II. TETRADECAPODS.

III. ENTOMOSTRACANS.

IV. ROTIFERS.

Form, under rather wide limits of range, distinguishes the rders; with narrower limits, the next grade of Orders; very istinctly, the third grade, the Maioids being called triangular rabs, etc., and still more distinctly and usually without the aid f ordinal distinctions, Families, or the next range of subdivisions.

We do not undertake at this time to inquire particularly into ie subordinate groupings.

The Brachyura, on what may be called their normal level, are reatly multiplied in species, and among either the Maioids, ancroids or Leucosoids, difference of rank is little apparent in ie great majority of species. Here Families may be distinuished by *form*, though hardly by this exclusively. But there re genera in which the groups decline from the normal level, nd the decline once begun, goes on with rapid increase from ne genus to another. Among the Maioids, the decline is seen istinctly in the Parthenope group which has not the close comact head and head organs of the Maioids, but approximates in iese respects to the Cancroids; it is more obvious still in the iferior genera of the group, Trichia and Oncinopus; and from iese it goes off by leaps through the Anomoural genera, Dromia, nd Lithodes to Pagurus.

The Cancroids and Grapsoids show more signs of grade among ie ordinary genera than the Maioids. From the level of the ancroids, on which the species are the most numerous, there is declining grade through the Grapsoids, from Gonoplax to Pinothera; and the declining curve at last descends rapidly irough one or two Anomoural genera. The Corystoids have istinct ordinal relations among the families and the lowest is nomoural.

The same system of remarks applies to the Macrourans; the bservations about the Maioids, Cancroids and Corystoids, reectively to the Astacoids, Caridoids and Penæoids; and those bout the degradations of the Brachyura or the Anomoura, to ie Schizopods or degradations of the Macroura.

We hence note the following facts: (1) the great multiplication f species on what may be called a normal level, where grade is ldom or but slightly distinguishable: (2) the fall from this vel, becoming a more and more rapid descent, so that grade is bserved even among Families and also Genera, because the type here "drawn out long"; (3) the small number of species existg below the normal level along the declining grade. The numer of ordinal degrees of subdivisions in Crustacea—that is, subivisions in which grade is distinctly marked,—is not necessarily law for other groups, because, as before said, this class is few in ecies, and is expanded over an immensely wide range of grade, striking contrast with the class of Insects. The same number degrees of subdivisions might have existed without distinct

ordinal relations, and then structural type would have been the sole reliance in classification, as it is in a great number of instances.

In groups like that of the Crustacea, or wherever the lines of grade are declining or are long drawn out, and occupied by comparatively few species, there is a chance for naturalists to reduce the groups called genera to one-species genera; while in those upon the normal level on which the principle multiplication of the species occurs, genera naturally are numerous in species. Nature seems to give us a caution here as to laying down unbending criteria for generic subdivisions, irrespective of the group under consideration. When our system of classification runs downs into numerous monotypic genera, it appears to us to be failing of one great purpose, which is, to exhibit *groups* of species, in their true relations.

The *application* of the views brought forward by Prof. Agassiz, we suspect will give the greatest occasion for diversity of judgment. He has not sketched out the system in zoology in order to exemplify his principles, and has only mentioned hypothetically the names of the Classes of Vertebrates. Instead of the ordinary number, Mammals, Birds, Reptiles, and Fishes, there are the following: Mammals, Birds, Reptiles, Amphibians, Selachians, Ganoids, Fishes proper, and Myzontes,—the last four being dismemberments of the group of fishes, and the preceding two, of Reptiles. The subdivision of the Reptiles had been before suggested; but the Fishes are here for the first time divided. On this subject, he observes, p. 186:

"The number and limits of the classes of this branch (the Vertebrate) are not yet satisfactorily ascertained. At least, naturalists do not all agree about them. For my part, I believe that the Marsupialia cannot be separated from the Placental Mammalia, as a distinct class, since we observe, within the limits of another type of Vertebrata, the Selachians, which cannot be subdivided into classes, similar differences in the mode of development to those which exist between the Marsupials and the other Mammalia. But I hold, at the same time, with other naturalists, that the Batrachia must be separated, as a class, from the true Reptiles, as the characters which distinguish them are of the kind upon which classes are founded. I am also satisfied that the differences which exist between the Selachians, (the Skates, Sharks and Chimæræ,) are of the same kind as those which distinguish the Amphibians from the Reptiles proper, and justify, therefore, their separation, as a class, from the Fishes proper. I consider also the Cyclostomes as a distinct class, for similar reasons; but I am still doubtful whether the Ganoids should be separated also from the ordinary Fishes. This, however, cannot be decided until their embryological development has been thoroughly investigated, though I have already collected data which favor this view of the case. Should this expectation be realized, the branch of Vertebrata would contain the following classes:—

1st Class: Myzontes; with two orders, Myxinoids and Cyclostomes.

2d Class: Fishes proper; with two orders, Ctenoids and Cycloids.

3d Class: Ganoids; with three orders, Cœlacanths, Acipenseroids, and Sauroids; and doubtful, the Siluroids, Plectognaths, and Lophobranches.

4th Class: Selachians; with three orders, Chimæræ, Galeodes, and Batides.

5th Class: Amphibians; with three orders, Cæciliæ, Icthyodi, and Anura.

6th Class: Reptiles; with four orders, Serpentes, Saurii, Rhizodontes, and Testudinata.

7th Class: Birds; with four orders, Natatores, Grallæ, Rasores, and Insessores, (including Scansores and Accipitres.)

8th Class: Mammalia; with three orders, Marsupialia, Herbivora, and Carnivora."

Here then, at the very first step, there will probably be a division among naturalists as to the signification of the principles laid down. Some will assume, and correctly as we believe, that the adult form of fishes and reptiles is the true expression of the potentialities of the type, and should alone be regarded in determining Classes, and that embryogeny can rightly come in only to form Subclasses; while others may take as a basis the whole range of structure through development. It is obvious too that there is room for wide diversity in the use of the other subdivisions, down to genera and even species.

Again, if the subdivisions of fishes above mentioned are called Classes, some may ask, what name shall be applied to this entire group, the rank of which would be between Branch and Class?

Whatever may be the final conclusion on these points, the discussion which has been pursued by Professor Agassiz has already borne science to a higher level than it had before attained, and given a force and direction to thought which will insure rapid progress towards perfection. The work proceeds next with its special topic, the *North American Testudinata;* and the subject is carried out with that thoroughness of research and beauty of illustration, reaching even to the structure of the embryo and its whole course of development, which is just what is needed for a full demonstration of the truth, on the points in science still open to discussion. Moreover, the volumes by Agassiz which are to follow in the series, will make still broader the foundation for the true philosophy of nature. We shall look eagerly for the last words on this subject from his searching mind.

The review of the Embryological part of the volumes forms a separate article, and is prepared by Mr. H. J. Clarke, Professor Agassiz's assistant, the results of whose microscopic investigations appear upon many of the pages and plates of the work.

ART. XXIX.—*Recapitulation of the "Embryology of the Turtle," as given in Professor Agassiz's "Contributions to the Natural History of the United States of North America,"* Vol. II, Part III; by H. JAMES CLARK, of Cambridge, Mass.

THE following summary, of the "Embryology of the Turtle," was undertaken at the request of Professor J. D. Dana, one of the editors of this Journal. For certain reasons, given below, it will be seen that neither comment nor criticism upon the work is in place here. The method adopted in writing out this subject, as it stands in the original work, is so far from the aphoristic style that I find it will be next to impossible to make extracts, which will give the pith of the matter, without inserting here a great portion of the whole. On this account I shall be compelled to rewrite, whatever may be presented, in a condensed form, with perhaps here and there a short extract.

Had it not fallen to my lot, as Professor Agassiz's assistant, to write out the embryological portion of these "Contributions" I would not have dared here to take the liberty of reconstructing the fabric of the story of the development of the Turtle. As it is, it will not be possible, for want of room, nor really necessary, to render account of the whole history as originally written, but I will confine myself mostly to what is new in this department of science.

Whenever anything is presented to the scientific world as new and especially controvertive of old and perhaps apparently well established views, every caution is necessary in proving that all liability to error has been guarded against whilst pursuing the investigations.

On this account considerable care has been taken, in the opening part of the "Embryology," to state clearly, and how that the egg and embryo, so called, were kept in as natural a condition as possible. In the study upon the origin and development of the egg, "a young animal was resorted to on account of the greater abundance of the smallest sized eggs and also because the ovary is less opaque than in the adult."

The origin of the egg.—The ovary was cut out entire and floated in serum, so that the eggs might not be distorted by pressure nor by pulling and tearing in order to get them under the microscope. In the first place a comparative view was taken of the whole mass of the eggs, from the youngest to the oldest, with a low magnifying power, and in this manner a rapid survey was made of the respective condition of each egg, and the mind prepared in part, by anticipation as it were, to more readily comprehend the relation of the phase of any one to that of any other or of the whole.

'he physiognomy of the egg in its younger stages is so pecu- with its thick dark outline, brilliant, strongly refractive, ıogeneous, yellowish contents, and the lateral nucleus, that ınnot be mistaken for one of the cells, of the corpus graafia- a, which press upon it from all sides. "The initial form of ;gg is a dark, oily looking, granule-like, spherical body, situ- l among the interstices* of the cells of the corpus graafianum. the latter not only, but even their nuclei surpass such an in size by several diameters, it is superfluous to debate the stion, whether the egg may not be the nucleus of a cell of generating organ."

ıt first the egg has no wall about it, but finally by a differen- ion of the superficial particles a consistent envelop is elabo- d and answers to the name of the *vitelline sac.*

he origin of the Purkinjean vesicle.—About this time, or soon r, the Purkinjean vesicle—germinal vesicle oftentimes called ecomes visible, by a condensation of a portion of the homo- eous yolk against the inner surface of the vitelline sac. The le of origin of this vesicle is very important to notice, be- se it bears reference, in a very pointed manner, to the theory the origin of free cells. Here it is evident that the egg-cell not originate, as is usually stated of cells, around its nucleus, that its nucleus is the offspring of the cell which encloses it. Purkinjean vesicle always remains close to the parieties of egg, even to the time when it disappears, and in no way nts to a falsely claimed relation to fecundation and the origin the embryo. The wall of this vesicle originates like that of vitelline sac, about a previously conglomerated mass of ticles.

The appearance of numerous vesicular bodies, known as the ıgnerian vesicles, upon the inner surface of the wall of the rkinjean vesicle, completes the operations, which have here n going on, necessary to the perfecting of the egg-cell, and rendering of it, although a *cell*, totally different in properties m all other apparently similar cells.

The development of the yolk.—It will be more convenient after s, on account of the complicity of the contents of the egg, to at of its different constituents separately. We will commence h the yolk first, as that is the fostering substance from which the other components essentially originate. Previously to

* "The first blood corpuscles are yolk-cell nuclei which have undergone changes itical with those of the whole 'embryo,' and they alone remain free, circulating ne channels hollowed out in a mass of cells identical with themselves. These the first cells originating interstitially, but yet, after all, not essentially so, as is case with the egg; for each blood corpuscle is a segment of an original yolk-cell eus, which has gone through the process of self-division; whilst the egg originates as the primary yolk-cell does, by conglomeration of particles, and the formation membrane around the parieties of this concretion."

the development of distinct yolk cells, the yolk passes through some peculiar granulated phases, the most remarkable of which is the gradual encroachment of granules, commencing at one side of the egg, upon the hitherto homogeneous contents, till they pass across the whole bulk of the vitellus. At one time, during this progressive incursion of the granules, the egg appears as if a half of two different eggs had been stuck together, one-half being homogeneous and the other thickly granulated. After the granular stages, at the time the egg is about one-sixteenth of an inch in diameter, the oily looking granules gradually disappear and at the same time minute hyaline, albuminous, vesicular bodies begin to develop. These again, as is the case with the egg-cell and Purkinjean vesicle, originate without the intervention of a so-called nucleus,* and each one grows for some time without the least sign of a second body within its wall.

"Here then we have essentially, nay in every sense, a cell, a hollow layer of spherical surface derived from the lateral adherence of the superficial particles of a homogeneous globule. It is not a cell formation by the hollowing out of a solid substance, forming at first a very thick wall, which would stretch by the increase of the contents, as it gradually surrounds a larger space, till it thins out to the ordinary crassitude of such envelops. Never, throughout the whole range of cell development in the egg, is there the merest hint of this mode of genesis. From the beginning to the end of the growth of the ectoblast it ever preserves the same thin stratum, apparently of a single layer of corpuscles, and moreover the same tenderness and the same refractory power. Nor can we compare this process to the received mode of cell origin according to which a wall is condensed around and upon a 'nucleus,' for the mesoblast is often

* "Thus far we have employed, in our descriptions of the egg and its contents, the nomenclature generally in use to designate its different parts, and those of the cell. But this nomenclature, framed to express particular views respecting the mode of formation and the functions of these parts, is completely theoretical in its meaning. It appears desirable, therefore, now that we are about to consider more fully the origin and successive growth of the yolk cells, to discard every technical expression which may imply a theory, and to adopt such only as designate the natural relations of the objects under consideration, especially since the views to which we have arrived cannot be reconciled with the theories which the current nomenclature is intended to express. These parts are therefore designated in the sequel by the following names: *ectoblast* is applied to the outer envelop; *mesoblast* to the so-called nucleus; *entoblast* to the so-called nucleolus; and, when this contains a still smaller body, this is called *entosthoblast*.

In the nomenclature of the egg, similar objections may be raised against the use of germinal or germinative vesicle and dot, as neither of these parts has the slightest reference to the formation of the germ. We shall therefore designate them, henceforth, as some embryologists do, by the names of the Purkinjean and Wagnerian vesicles. Applying our nomenclature to a comparison of the egg with the cell, the *yolk-membrane* is to be considered as an *ectoblast*, the *Purkinjean vesicle* as a *mesoblast*, the *Wagnerian vesicle* as an *entoblast*, and the *Valentinian vesicle* as an *entosthoblast*."

absent in quite large cells; in fact, an egg little more than one-sixteenth of an inch in mean diameter contains numerous cells of considerable size, no one of which contains a mesoblast. Nor can it by any possibility be advocated, that these cells are the contents of other cells, for no others exist; even in a much larger egg, up to full grown ones, this holds good just as undoubtedly, for in such a mass of yolk as larger eggs contain, the mesoblasts and ectoblasts have respectively very peculiar and unmistakable properties, not to be confounded with any other cell contents."

No ectoblast, as these albuminous hyaline vesicles are called, which has attained to a diameter of $\frac{1}{4000}$th of an inch, is without a mesoblast. This latter body, like the Purkinjean vesicle, originates as a conglomeration against the wall of the cell,—the ectoblast,—which directly encloses it, but as soon as it has become well defined in outline it breaks away from its attachment and takes up a position in the centre of the parent cell.

Notwithstanding that the mesoblast soon loses its globular shape, which free cells usually assume, and passes through some rather sharply angular phases, and finally ends with becoming more or less irregularly spheroidal, it appears to have a superficial layer of its mass so consistent as to constitute a wall. Inasmuch as a cell wall has been found, here, in these investigations, to have no definite density and in some cases to be hardly differentiated from the substance which it contains, it has been thought best to extend the definition hitherto used, and characterize it as "a hollow, more or less spherical layer, of indefinite density, tenacity, and refraction, which surrounds the field of some definite though isolated and homogeneous function."

By the time the egg has attained to its ultimate size, within the ovary, the mesoblast has grown so large as to almost completely fill the ectoblast. The size of the mesoblast, at this period, is enormous, far exceeding in this respect the mesoblast of any other free cell known, being about $\frac{1}{730}$th of an inch in diameter.

Perhaps the most remarkable of all the constituents of the egg are the entoblasts of the yolk cells. These bodies appear about the time the egg has reached from one-eighth to one-sixth of an inch in diameter; a single one at first originates in the centre of the mesoblast, and not at the side as we have seen in other cases, but soon others take their places around the first. The marked peculiarity of these bodies is their sharp angularity, from the time of their origin, which increases till they resemble spiculæ; and eventually fill, to surfeiting, the mesoblast. Then, when the egg has reached a diameter of one quarter of an inch, these angular, crystalloid entoblasts begin to lose their corners,

and many to disappear altogether, whilst new ones, with rounded angles and more equilateral, develop in place of these.

The Purkinjean vesicle.—We have already described the mode of origin of the Purkinjean vesicle, and mentioned the appearance of the Wagnerian vesicles. These last are developed at first few in number, but subsequently they cover, like drops of dew, the whole inner surface of the wall of the Purkinjean vesicle. Like all cell development heretofore described, the Wagnerian vesicle begins with a faintly visible conglomeration of particles, which eventually obtains a well defined outline. The Valentinian vesicle is remarkable for having very little refractive power, so as to appear like a flat disc in the midst of the parent cell, the Wagnerian vesicle.

By the time the egg has become one quarter of an inch in diameter, the Wagnerian vesicles disappear and give place to an almost total homogeneity of contents in the Purkinjean vesicle. From this time forward the latter grows more and more albuminous, and may be hardened, by boiling the egg, so as to be taken up on the point of a knife. This albuminousness is so marked in the mature ovarian egg that boiling contracts the vesicle by nearly one-half, and the side next the yolk sac becomes collapsed.*

The Zona pellucida.—The zona pellucida, which eventually takes the place of the yolk sac, when the latter becomes resorbed,

* "The clear space, observable in the egg of various animals just previous to segmentation, to which the name of "embryo-cell" has been given, from its supposed intimate connection with the formation of the germ, may be identical with the white area about the Purkinjean vesicle observed in Testudinata. We would take this opportunity to express the opinion, that very probably too much stress has thus far been laid upon the assumption that the Purkinjean vesicle performs a peculiar and exclusive function in reference to the formation of the so-called embryo-cells; and, moreover, that the Purkinjean vesicle is not to be so definitely separated, as regards its essential element, from the immediately juxtaposed substance of similar appearance, but should rather be looked upon as the crowning point of albuminous concentration, to which the opposite side of the egg stands in the reverse extreme of a highly oleaginous nature. A reference to the mode of origin of this vesicle shows this conclusively; for it is developed as a phase of secondary accession in the egg-evolution, and not as the primary basis to a succeeding structure ever after retaining a significance of superior import, and leading, as some would have it, to its becoming in the end the essential element in the genesis of the embryo. This mode of origin alone, we maintain, is sufficient to show that the very foundation upon which its importance is laid cannot be tenable, in this light. The Purkinjean vesicle, therefore, loses all its advocated claims to preponderance over the rest of the egg constituents; to say nothing of the fact that it takes no part in the building up of the blastoderm, excepting that its discharged contents may become absorbed in the endosmotic and exosmotic interchanges of substances between the oily yolk cells, and the albuminous matter in which they float. True enough, the region about this vesicle exhibits a specialized nature; it is there that the embryo first develops certain of its characteristics, previous to its further extension; but it does not follow, that because the Purkinjean vesicle is situated thereabout, it is the basis of this evolution, or in any way causatively connected with it. On the contrary, its presence is itself rather the result of certain tendencies, for instance, the concentration of albumen in that direction; and its disappearance also is the consequence of the consummation of these tendencies."

ırmed by a stratification of the inner cells of the Graafian :le, and therefore is not developed inside of the yolk sac, as been asserted of it by some authors when treating of its n in the eggs of other animals. Eventually the zona ap- ɜ as if made up of columnar cells, and thus remains during rest of its existence. It may be detected even as late as ı the amnios has begun to form.*

ie Embryonal Membrane.—The embryonal membrane is a :, originating by a transformation of the superficial part of yolk when the egg is hardly visible to the naked eye, and ormation of an excessively transparent cellular tissue, which lops the whole vitelline mass. In its earliest stages it can- ɔe compared nor homologized with anything heretofore no- . in the eggs of animals, but when the embryo has begun ɜvelop, it occupies the same relative position as the "*Keim-*" of Bischoff, or the "*Umhüllungshaut*" of Reichert, and the *esting membrane*" of English authors. Yet, insomuch as the *esting membrane*" of these authors, according to them, does develop till the embryo begins to form, it cannot, for a cer- ;y, be homologized with the *embryonal membrane* of the tur- egg. But it is remarkable that this membrane like the resting membrane" follows all the curvatures of the dorsal ɔn of the embryo and even becomes a lining to the spinal . At the time the turtle is hatched this membrane may be ɔted as readily as in any of its earlier stages.

ɜcundation.—Professor Agassiz's observations are so remark- . and the facts in regard to fecundation so unprecedented, I think it worth while to quote here the whole of the sec- he has written on this subject.

Ever since I have known that our Turtles lay only once a year, I been struck with the fact that the ovary nevertheless contains eggs

' Thompson (article *Ovum* in Cyclop. Anat. p. 78) compares the early yolk-sac ds (which he hardly admits as a true *membrana vitelli*, notwithstanding Meckel's ·ches) to the zona pellucida of Mammals, (the true primary vitelline sac of animals, interior to the zona, being totally ignored by him; see also p. 50, ; he describes the zona as the original yolk-sac and the only one existing in nals) and the secondary yolk-sac (the true zona) to the tunica granulosa of vi- ɔus vertebrates. The secondary yolk-sac, he infers, is derived from the cellular of the Graafian follicle; but, since at the same time he makes it merely the or stratum of a concentric series, the inner of which he insists become the true v yolk granules, (the primary yolk-sac, zona pellucida, as he calls it, having ɔeared by deliquescence) it looks very much as if he had mistaken the devel- nt of the 'membrana investiens' for that of the membrana vitelli. Again he p. 78), 'the external edge of the layer of prismatic cells, the length of which is lerably increased, is now surrounded by a narrow pellucid space inclosed by a e line, presenting the appearance as if a small part of the bases of these cells ɔeen fused together in a homogeneous film.' This probably is the true zona :ida of Birds; he having failed to see the membrana vitelli (already disappeared thinks), situated between it and the layer of prismatic cells, from which latter ɔposes, but without direct research, that the 'pellucid space' because of its of hexagonal markings, is an immediate development."

of very different sizes. I was led by this observation to inquire into the duration of the growth of the ovarian eggs, when I further noticed that these eggs appear in well-marked sets of different sizes, each set being equal in number to the average number of eggs laid by the species under observation. It thus became evident that the eggs require more than one year for their full development. Once upon this track, it appeared practicable to determine how long a period this growth embraces; for, as soon as it could be ascertained how many eggs different species of Turtles lay, there was a standard of comparison obtained for the investigation of the ovaries; and, as I early learned that the species most common about Cambridge exhibit marked differences in that respect, I selected these species for my first studies. Chrysemys picta lays always between five and seven eggs. I have never observed as few as four, and only occasionally eight. Nanemys guttata lays generally two or three; I have only once or twice found four eggs in its nest, and three times in its ovary. There was therefore no chance of making any mistake, when comparing the number of their ovarian eggs with that of the eggs they lay, after I had ascertained that a few weeks before the breeding season there are the same numbers of mature eggs to be found in the ovary as these species usually lay in the spring. I felt still greater confidence in the possibility of coming to precise results, after I had found again and again the very same number of eggs in the oviduct, and noticed that at that time another set of eggs could be readily distinguished, of the same number as the larger eggs left in the ovary. Indeed, the difference between this largest set of ovarian eggs and the smaller ones is so great, even at the time when the eggs about to be laid are still in the oviduct, that they are distinguished at the first glance; for, though they have unquestionably to remain another year in the ovary, they are already nearly as large in diameter as those which have just left it.

"With a knowledge of these facts, it was easy to arrive at a full understanding of the normal periodicity in the growth of the ovarian eggs. It soon became plain, that shortly before the period of laying there were not only two, but as many as four, distinct sets of eggs in every ovary; and that, after the largest set had been laid, a new small set was started from among the innumerable smallest eggs of variable size. It now seemed that a single question remained to be answered. What is the age at which the Turtle discloses for the first time such differences between its eggs? Upon opening large numbers of young Chrysemys picta it was ascertained, that, up to their seventh year, the ovary contains only eggs of very small size, not distinguishable into sets; but that with every succeeding year there appears in that organ a larger and larger set of eggs, each set made up of the usual average number of eggs which this species lays, so that specimens eleven years old, for the first time, contain mature eggs, ready to be laid in the spring.

"Now another question arose, When are the eggs fecundated? Field observations soon taught me that this species copulates before it is eleven years old; I have even seen those that were not over seven years old already performing the act, though I have never seen any in copulation younger than these. Thus it appears that the first copulation coincides with a new development of the eggs, in consequence of which, a certain

number of them, equal to that which the species lays, acquire a larger size, and go on growing for four successive years before they are laid, whilst a new set is started every year, at the period of copulation in the spring, enabling this species to lay annually from five to seven eggs, after it has reached its eleventh year.

"The question was then naturally suggested, whether fecundation is the result of the first act of copulation, or of the second, the third, or the last; or whether the first copulation only determines the further growth of a certain number of eggs, which require a series of successive fecundations to undergo their final development. The second alternative appears the more probable when it is remembered that Turtles were observed which did not lay their eggs as usual, though the yolk had undergone all the regular changes through which it passes, up to the time the egg has entered the oviducts. This is another fact which tends to prove that fecundation is a successive act. Though Turtles lay only once every year, soon after the period of copulation in the spring, copulation itself does not take place once merely, every year, as in all the animals known to bring forth young once annually; it is repeated a second time, every year, in the autumn, shortly before the Turtles retire to their winter quarters; and this takes place without apparent connection with any marked change in the growth of the egg at that season. So, in Turtles, fecundation does not appear to be an instantaneous act, resulting from one successful connection of the sexes, as it is with most animals. The facts related above show, on the contrary, that, in Turtles, a repetition of the act, twice every year, for four successive years, is necessary to determine the final development of a new individual, which may be accomplished in other animals by a single copulation.

"It may be suggested, that, by an investigation of the spermatic particles, additional light would be thrown upon these remarkable circumstances. But such investigations present greater difficulties in these animals than could be supposed at first; and notwithstanding the most diligent search, my efforts to trace the spermatic particles through the oviduct, as high up as the ovarian eggs, have been unsuccessful. Turtles do not copulate in confinement; and those which I could catch in coitu in their native haunts have only exhibited spermatic particles in the oviduct. I have, still less, been able to trace the sperm into the egg itself. Indeed, there is no micropyle in the egg of Turtles; and I must confess that I have not yet seen the first fact which could lead me to admit that the spermatic particles penetrate into the egg. I am therefore obliged to abstain from expressing any decided opinion upon the question of the penetration of the spermatic particles into the egg, which has of late attracted so much attention among embryologists. I can only say, that, notwithstanding the high authority upon which it is asserted as a fact that the spermatic particles do pass into the substance of the egg through a definite aperture of its envelope, I am still rather inclined to doubt it.

"The aperture observed in the outer membrane of the egg, which has been called micropyle, has always appeared to me to be the result of the separation of the sac in which the egg is developed, and by no means to pass through the vitelline sac. Without the most careful examination it is not possible to perceive how complicated the sac is, in which the egg

is inclosed; and I suspect that a kind of Graafian follicle, which in many animals drops from the ovary with the egg, has frequently been mistaken for a vitelline membrane. I believe, further, that the scar resulting from the separation of that follicle forms the opening called micropyle, and that this opening does not traverse the vitelline membrane. In Turtles the perforated appearance of the yolk sac arises from the presence of the Purkinjean vesicle near the surface of the yolk, and not from the existence of a real hole. After what has been said above of the lateral origin of the Purkinjean vesicle, it is superfluous to insist upon the incorrectness of the view of those who would ascribe its superficial position to the influence of fecundation. It is formed in that position, and preserves it as long as it exists."—pp. 489–492.

Egg Laying.—By careful comparisons, it has been possible to ascertain at what age at least one species begins to lay its eggs and reproduce its kind. Chrysemys (Emys) picta does not lay its eggs before the eleventh year. With other turtles the data were not so complete, but in all probability they may be said to lay their eggs from the eleventh to the fourteenth year, according to the species. They all do this too in the spring, in the month of June, both at the north and south; physical differences not seeming to have the least effect upon this particular function.

The formation of Albumen.—The mode of formation of the albumen is very different from what it is among birds, there being no chalazæ nor spiral arrangement of the layers. The shell and albumen are both deposited at the posterior end of the oviduct, and the albumen is not applied against the surface of the yolk by direct contact of the inner surface of the oviduct, but in a great measure infiltrates through the previously formed shell membrane.

The albumen is composed of innumerable layers of amorphous substance, in which are imbedded a multitude of elongate, oval, coarse, granular bodies pointing in a particular direction in each layer, some along the longer axis of the egg, some across the same, and others in intermediate directions between these two.

The shell membrane.—This arrangement is carried out in a beautiful manner in the shell membrane whose inner layers are composed of the same sort of oval bodies, arranged end to end, and forming a beaded thread. Going outwardly these oval bodies become more and more blended with each other till finally they form a mesh of uniform, even fibres, of excessive thinness and nacreous aspect.

The shell.—The shell is deposited in what appear to be exceedingly tender layers of albuminous substance originating after the manner of the albumen and the shell membrane. The shell is composed of characteristic groups of carbonate of lime, more or less intimately soldered together side by side, each

group or nodule consisting of concentric layers of columnar crystals.

The absorption of Albumen.—The albumen is absorbed into the yolk sac in a very peculiar manner; the outer layers are removed first, at a point always above the embryonic disc, so that in the end an inverted conical hole is formed. From this hole the absorption spreads centrifugally till all the albumen is drawn into the yolk sac, or zona pellucida now, and the latter has distended so as to completely fill the shell. At or near the time that the absorption of the albumen commences, the segmentation of the yolk begins; and the embryonic disc is formed, in some species, before the clear hyaline space appears under the embryo.

Self-division of the Mesoblast.—Before we describe the segmentation of the yolk, it is proper to mention another kind of segmentation never before observed in the eggs of any animal. We refer to the self-division of the mesoblast of the yolk cell. This takes place, at least to a certain extent, without the influence of fecundation within a year, but at the same time has been seen only in those eggs which have been expelled from the ovary. Moreover this happens before the so-called segmentation of the yolk mass, and in fact is a forerunner, as if to prepare the way for the latter change.

The mesoblast, which by this time so completely fills the cell that the ectoblast appears like a bright and very narrow halo about it, usually divides at first into two equal portions, rarely into three, each of these into two more, and they each again and again into two more till the ectoblast is filled by an innumerable host of mesoblasts. This process goes on slowly, and lasts as long as the young turtle is within the shell. It is completed first in those ectoblasts which enter into the formation of the embryonic disc, and afterwards in those which are added to the later formed parts of the embryo. After the segmentation of the yolk mass, the ectoblasts become resorbed and the innumerable mesoblasts are left in heaps, which are at first quite distinct, but gradually they blend with each other till finally they form a uniform layer all over the disc and the whole extent of the germinal layer.

The great point gained by these last observations, is to prove that these *self-divided mesoblasts* become the original cells, "*the primitive embryonic cells*," in the composition of the different organs of the body.

The segmentation of the yolk.—The segmentation of the yolk mass has been seen in the eggs of only one species of turtle, *viz:* Glyptemys (Emys) insculpta. This was observed for the first time on the 27th of May, 1854, and afterwards during the two succeeding days, in a series of eggs taken from three different individuals. The process of segmentation is not so regular, and

there does not seem to be always, in the beginning, a symmetrical halving of the embryonic area, as has been observed among birds; but in other respects it resembles what takes place within the eggs of the latter animals, and finally results in shaping out the embryonic disc. The most remarkable features to be noticed in the egg at this time, are certain phenomena which tend very strongly to show that segmentation is not confined to the embryonic area, at the upperside of the egg, but that, as has never before been noticed in oviparous allantoidian animals, the whole mass of the yolk becomes segmented.

The whole egg is the embryo.—"Since we have shown in former pages, that the embryonic disc, and its extension, the germinal layer, are formed by the original apposition of yolk-cell mesoblasts minutely subdivided, and that these yolk-cells are all the same through the whole yolk mass from centre to surface, even to the very walls of the superficial Purkinjean vesicle; and, moreover, since it is proved that segmentation obtains beyond the embryonic disc, and very probably all over and throughout the whole yolk, it is evident, that, in the egg of the Testudinata at least, the region around the Purkinjean vesicle cannot be separated from the more exterior or inferior mass which constitutes the greater bulk of the vitelline substance, and that the last cannot be homologous to the contents of the Graafian follicle, which bears no part whatever in the formation of the embryo, but is totally exterior to the Mammalian egg. Again, as will be shown hereafter, that portion of the yolk which is originally excluded from the primary circumscription of the outlines of the embryonic disc cannot be separated from the animal as an appendage, for it very soon afterward becomes an essential part of the 'embryo,' as the latter extends itself in the form of a germinal layer and a vascular area, not only all over the surface of the yolk, but in the case of the area vasculosa, throughout the whole vitelline mass, the latter becoming a great spongy network of blood-vessels, formed by the lateral apposition of the cells composing this large body. This vascular mass is finally drawn into the body, and though gradually disappearing by resorption, remains for nearly six months after birth as one of the essential portions of the organization of the freely moving animal."

The formation of organs.—The first step taken that indicates the formation of organs, is the originating of a furrow around and close to the edge of the embryonic disc. The furrow is the folding of the germinal layer as it begins to turn upward to form the *amnios*. At this time there are two layers all over the surface of the yolk mass; the outer one, the *germinal layer*, is very thin, excepting where it enters into the composition of the embryonic disc; the inner layer, the *subsidiary layer*, is quite thick, and forms the basis of all the organs, except the cerebro-spinal

marrow. The germinal layer performs a triple office; in the median line of the embryo, it forms the basis of the "primitive furrow" which is the incipient spinal marrow; exterior to this it constitutes the musculo-cutaneous layer; and more exteriorly still, it folds upwards over the back of the embryo, and becomes the amniotic sac.

The vertebral lamina is formed by the separation of a broad band, about equal in length with the embryonic disc, of loose, unconnected cells, from the upper surface of the subsidiary layer. From this the vertebræ are developed after the usual manner among vertebrates. The cells in the median line of the vertebral lamina become changed very soon, and more compact and united, forming the chorda dorsalis, or the axis of the young vertebræ, which are not as yet apparent. By the development of the chorda dorsalis, the vertebral lamina becomes equally divided into two laminæ lying right and left of the axis of the body. In about twelve days from this time, when four or five vertebræ have appeared, and the spinal marrow is closed over in the anterior of the cerebral region, the subsidiary layer has developed a thick annular ridge on its under side all around the embryo, at a short distance beyond the confines of the original embryonic disc. This ridge eventually becomes a hollow mesh, like a sponge, and then constitutes the *vena terminalis*. Cotemporaneously with the last, another change occurs in the subsidiary layer by which it becomes separated along the median line of the ventral side of the body, from the vertebral laminæ above it, and the heart and dorsal artery are hollowed out in its upper side. Soon after this the omphalo-meseraic arteries are also hollowed out in the upper surface of the same layer from which the heart and dorsal artery originated. In these vessels a granular albuminous fluid surges backward and forward; thus evincing at this early period a beginning of blood circulation in vessels which do not form a complete circle with each other. It is very easily seen that the heart is the impelling power in this case.

The mode of formation and development of the Wolffian bodies is so simple that it is a wonder there has been so much dispute among embryologists about their genesis. They originate as mere thickenings of the subsidiary layer, around and obliquely above each abdominal vein, and leaning over toward the dorsal artery. Being in the same layer with the arteries and veins, the blood vessels of the two systems meet in these organs through very simple channels, running as yet direct from the principal artery to the principal vein. About this time, when the heart has become three-chambered, the vertebræ reach to the root of the tail, and the eyes have become entirely enclosed in complete orbits, the allantois begins to grow. Its formation is as simple

as that of the Wolffian bodies, and developed in the same layer with these.

The subsidiary layer approximates its opposite sides and uniting them, arches over a certain space so as to form a sac. At first this sac does not project beyond the body. Soon after or almost synchronously with its formation the allantoidian arteries and veins are developed by simply hollowing out channels direct from the dorsal artery into the allantois, and thence, all in the same layer, into the allantoidian veins which course along the edge of the abdominal opening. Now too the embryo turns upon its axis, and rests always upon its *left side.* Why it rests upon this side and not upon the other, sometimes at least, is simply because this position belongs to its plan of development. A little later the omphalo-meseraic arteries have joined their numerous currents into one single vessel for a short distance from the dorsal artery. The nostrils have begun to develop at this period, and may be recognized as two simple indentations at the end of the head. They have no communication with the mouth at this time.

The vena terminalis merits attention at this time, inasmuch as it is as concentrated in its course as it ever will be. It never has, from the beginning, been a single vessel, as occurs with birds, but is composed of numerous closely set anastomosing currents, running parallel wise to each other. Not long after this time the vena terminalis, to one half of its circuit, sinks a short distance below the surface of the yolk, carrying along with it the afferent vein. The nostrils have grown deeper and broader, and communicate with the mouth, but only through a very shallow furrow, nothing like the deep channel which has been described in Mammals, but just deep enough to show that there is a tendency to follow the type of formation prevalent among higher Vertebrata. In the next step the nostrils become narrowed at the aperture, and the shallow furrow, mentioned above, is closed over, leaving a very narrow fissure to indicate its former position. The degree of communication between the mouth and nostrils in this case, is intermediate between that which obtains among Mammals where the mouth and nostrils are all one cavity during the early periods of development, and that of Fishes, where these two openings are always independent of each other. The shield begins to develop by a budding out laterally of the musculo-cutaneous layer along the sides of the body, and the development of narrow ribs extending to the very edge of the roof-like covering.

The feet, or rather paddles of the lower forms of turtles, the Chelonioidæ, do not remain in a partially undeveloped state, as might be expected from what is observed among other vertebrates, but undergo what may be called an excess of develop-

ment; the bones of the toes becoming very much elongated, and the web,—which remains soft among some turtles with moderately elongated toes,—is hardened by the development of densely packed scales, so that the whole foot is almost as rigid as the blade of an oar. About two months before the time they were hatched, some young of Chelydra (Chelonura) serpentina, were observed to move the head, feet, tail, lower jaw, tongue, and also the toes separately, and to roll the eyes. In a turtle a little older than these, the omphalo-meseraic vein runs in a direct line through the yolk mass, and joins the exterior boundaries of the vascular area at the lower side of the egg.

By the time the shield has become broadly oval the embryo assumes again an erect position in the egg, and thus remains till it is hatched. The embryo of Chelydra serpentina already shows its predaceous propensities, by snapping at everything which touches it. Just before the young were hatched the edges of the jaws were cut open longitudinally, and disclosed a series of small cavities, into each of which, a branch from the maxillary nerve ran. No doubt these indicate a typical tendency to the formation of teeth. When the young is hatching a large mass of the yolk sac is still hanging outside of the umbilical opening; but within a few hours it is altogether drawn into the body and occupies a large space in the abdominal cavity. The circulation in the yolk sac at this time is in full tide of operation. Externally the allantois withers and falls away, but, within the young turtle, its neck is persistent and becomes the urinary bladder.

The brain at this time does not extend in nearly a straight line, as is the case in the adult, but is still considerably bent downward at its anterior end. The eye presents some hitherto unknown peculiarities at this time; the capsule of the lens is a triple membrane, excessively thin, very tough, glassy, and elastic. It is this membrane which supports the "membrana pupillaris" and not the hyaloid membrane as has been claimed for some of the Mammalia. The "membrana pupillaris is a thick double membrane and does not seem to be resorbing, but on the contrary, would appear to be persistent through life, inasmuch as it was found in a turtle,—Trachemys scabra,—twenty years of age.

Histology.—A great part of the histology relates to the young turtle about the time it was hatched. In the formation of nerve fibres or tubuli, the olfactory nerve furnished the most conclusive proof that these tubuli originate by the soldering end to end of the nervous cells, and the obliteration of the intervening walls at the point of contact. All stages of development were represented here, from cells arranged in a line end to end, with partially absorbed walls, up to those where the only indication of

the position of the cells which compose the tubuli, were the mesoblasts (nuclei) arranged in a line at regular intervals. In the bones, the granular ossification presents nothing very remarkable; but, in the ribs, the relation of the outermost fibrous layers to the fibres of the corium of the shield, is very important to notice. The only difference observable between the fibres of the growing and widening edge of the ribs and those of the corium, was that the former were hardened by ossified granules deposited in lines, and the latter were perfectly soft. In all probability the wings of the ribs, which unite eventually and form in some turtles, a solid shield, are developed by the hardening of the component fibres, by calcification. In fact it would be difficult to determine how much of the shield is composed of the fibrous layers of the ribs and how much of calcified fibres of the skin. In the eye, the nervous fibres, which run in lines from the entrance of the optic nerve along the inner surface of the retina to its anterior border, do not spring directly from the optic nerve, as has been usually asserted in regard to the eye of Vertebrata, but are tail-like prolongations from each retinal cell, which lies abutting against the hyaloid membrane.

The whole retina, including the membrana Jacobi, is composed of five apparently distinct layers of cells. When examined closely these layers are seen to be only different varieties of cells. The cells of one layer send tail-like prolongations into the layer above and below, but in no instance have these prolongations been seen united so as to form a continuous string of cells reaching from the outer to the inner surface of the retina. In this respect the retina is lower in degree of development than that of Mammals, where H. Müller and Kölliker have seen the string of fibres in the greatest perfection. The epithelial cells of the stomach and esophagus are endowed with an unheard of arrangement of vibratile cilia. Instead of being scattered over the whole free surface, the cilia are placed in a circle forming a crown to the end of each cell. So that when seen face-wise the interior of the esophageal and stomachial cavity appears as if lined with a net-work of vibratile cilia. The surface of the lungs is covered by a thin layer of very pale round cells, with numerous dark granules intervening. Over the course of the blood vessels these pale cells are almost hidden by densely packed dark granules, arranged in two, three, four, or five rayed star-like heaps.

The blood corpuscles at first are very minute globular bodies, in fact, nothing more nor less than some of the cells of the subsidiary layer, loosened from the sides of the original blood channels. The cells increase in size and grow transparent; then they become oval, and the mesoblast leaves its lateral position and takes a central one, and finally in the last month of incubation

they begin to be flattened, and assume the discoid shape proper to the adult state. A short time before the turtle is hatched, the muscles attached to the dorsal arch exhibit very clearly how the fibres originate from the soldering of the ends of the spindle-shaped cells to each other, and the obliteration of the intervening walls. The granular contents of these cells is partially arranged in lines parallel with the sides of the developing fibres. In the muscles of the fore-leg the granules may be recognised as components of the fibrillæ, and as such giving the fibres a transverse striation.

ART. XXX.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio:* lat. 39°·25 N. and lon. 4°·28 W. of Washington City; by S. P. HILDRETH, M.D.

MONTHS.	Thermometer. Mean temperature.	Thermometer. Maximum.	Thermometer. Minimum.	Fair days.	Cloudy days.	Inches of rain and melted snow.	Prevailing Winds.	Barometer. Maximum.	Barometer. Minimum.	Barometer. Range.
January,	19°10	44	−11	12	19	1·55	N., N.W. & S. W.	29·85	29·05	0·80
February,	42·73	75	5	17	11	1·50	W., S. & S. W.	30·05	29·15	0·90
March,	37·91	78	8	20	11	1·30	N., W. & E.	29·70	28·85	0·85
April,	42·83	70	20	16	14	3·08	N., N.W. & S.W.	29·70	28·95	0·75
May,	56·95	86	36	16	15	5·16	N., S.W. & S.E.	29·55	28·80	0·75
June,	70·30	93	48	19	11	4·08	S., S.W. & W.	29·53	29·00	0·53
July,	74·44	96	52	16	15	4·87	S., S. W. & E.S E.	29·60	29·15	0·45
August,	72·33	92	52	20	11	5·21	S., S.W. & W.	29·55	29·15	0·50
September,	66·75	94	39	23	7	1·63	S., S.W. & N.& E.	29·70	29·25	0·45
October,	52·33	80	26	13	18	2·58	S., S.W. & E.	29·70	29·05	0·65
November,	40·37	82	10	15	15	4·84	S.W., & E.	30·00	28·40	1·60
December,	41·20	61	21	13	18	4·84	S.W., W., & E.	29·80	28·90	0·90
Year,	51·43			200	165	40·64				

The mean temperature for the year 1857 is 51°·43, which is nearly one and a half degrees above that of the preceding year. Both of these years are rather remarkable for the extremes of temperature both of heat and cold.

Rain and melted snow.—The amount of rain and melted snow is forty inches and $\frac{64}{100}$, which is a little below the mean for a series of years, generally estimated at forty-two inches, or three and a half feet. The deficiency is found in the three first months of the year, which are remarkable for the small amount falling at this period, being less than four inches: whereas in many years the quantity varies from eight to twelve inches. During the remainder of the year the rain was very equally divided, affording a full supply for the wants of the agricultural interests, and the healthy growth of forest trees. In the year 1856 the amount of rain was only thirty-two inches.

Winter.—The mean of the winter months is 30°·35, which is nearly five degrees above the preceding year, that being 25°·67—the lowest on record. The winter of 1857 was greatly modified, by the mild weather in February; the temperature of that month being 42°·73, while that of 1856, was 25°·50. It was also more mild than the month following, by nearly five degrees; a very unusual occurrence, that for March this year being 37°·91, and amongst the coldest on record, while February is the most mild. January was a very cold month; the mercury falling below zero on seven days, making the mean for the month 19°·10, while in 1856 the temperature of this month was 17°·87, with the same number of days below zero, but of a lower grade. The means of these two remarkable Januarys are the lowest on record at Marietta by more than ten degrees, and a mean average of at least fifteen degrees for the last forty years.

The cold over the southern portions of Ohio was very intense in January, much more so than in the year 1856. At Castellsburgh, Ky., lying at the mouth of the Big Sandy river and the most southerly bend of the Ohio, one degree south of Marietta, in lat. 38·30, the mercury fell to 30 degrees below zero—also at Ironton five miles lower down, in Ohio: being the 19th and 23d days of the month, while at Marietta a degree north, and eighty miles east, the temperature was at 8° below on the 19th, and 11° below on the 23d; indicating currents of cold in the atmosphere, like the currents of the ocean. This severe cold was felt many degrees south of the Ohio. The Cumberland river was frozen over at Nashville, so as to support men and horses in crossing, at Ironton the mean for the whole day was 14° below zero, on the 19th. This extreme cold destroyed the dormant fruit buds of the peach, pear, plum and cherry, but many of the apple escaped. In Washington county we had a fair crop of nearly all our fruits, except peaches, which were injured on budded trees, but full on those of natural stocks. The amount of snow was small, not more than six or eight inches; the greatest fall being about four inches. The ice in the Ohio river gave way on the sixth of February, and by the eighth, steamboats commenced running, having been embargoed since the 19th of December. This month in 1857 was mild and temperate, with the Ohio clear of ice, and an abundance of water for navigation.

Spring.—The mean of the spring months is 45°·89, which is three and a half degrees below that of 1856, and five and a half below 1855, and is mainly attributable to the low temperature of April, being 42°·83, while in the preceding years this month was nearly 55°, a difference of twelve degrees. It has been remarked that the mean temperature of the month of April for a series of years, represents that of the whole year in this climate. The month of May was also below the average temperature, being

only 52°·95, whereas sometimes it rises to 67°, and very rarely falls below 60°. This low grade made the spring quite backward, retarding the labors of the husbandman very considerably, and causing much additional toil, as he had to replant his cornfields once or twice, the seed rotting in the ground from a lack of the heat necessary to its healthy germination.

The blooming of fruit trees was much retarded. The pear peach, and cherry, not opening until the forepart of May, whereas they are usually in this condition early in April, or by the middle of the month. The apple deferred this important period until the ninth of May; and the locust was not in blossom until the ninth of June, nearly three weeks later than common. The disastrous effects of this extreme cold of winter was again seen on many flowering trees and shrubs. The buds of Magnolia conspicua were entirely killed, and a large portion of the M. tripetala destroyed; the latter being a native of this region was supposed to be entirely hardy. The Catawba grape and peach suffered less than in the preceding winter, but in many localities the fruit of the peach was destroyed. The quantity of rain for the spring months was nine inches and fifty-four hundredths; more than half of which fell in the month of May.

Summer.—The mean temperature of the summer months is 72°·35; which is a full average for this region, that of the extreme hot summer of 1856, being only 73°·55. That of this year was one of the most equable and pleasant seen for the last forty years; possessing all the requisites for a healthful growth of plants and vegetables of all kinds, an abundance of rain, without sudden changes from hot to cold, as we sometimes experience. It was as near to a temperate tropical summer as the climate will allow. The warm weather early in June put new life into the drooping corn crops, as well as other plants requiring a greater heat than that afforded by the month of May. The production of all the cereals was abundant, as well as that of the potatoe; which latter was never excelled in quality or in quantity. The latter part of June a moderate reduction of temperature prevented the rust in wheat, and favored the filling of the grains, so that the amount per acre was never exceeded. Sweet potatoes were abundant and very fine. The apple crop is seldom exceeded in amount, and never in quality—the fruit being not only large but of a very fair appearance, free of worms and dry rot. Peaches were scanty in amount and not so sweet as in more dry summers. The grape crop was good, but not so abundant as in some years, from the enfeebling effect of the winter. Man and beast participated in the salutary results of this delightful summer, being more free from diseases of all kinds than in many previous years. This healthful condition of the atmosphere seems to have pervaded the whole country, keeping off

cholera and yellow fever with all their collateral branches, from their accustomed haunts. It is a summer long to be remembered for its blessings. The quantity of rain is fourteen inches and sixteen hundreths, an ample supply for the consumption of the most hungry vegetation, while in 1854 it was only nine inches and ninety-six hundredths. The maximum height of the thermometer was 96° on the 17th day of July.

Autumn.—The mean temperature of the autumnal months is 53°·38, being nearly the same as in 1856, or 53°·31. November this present year was somewhat below the mean of that month, but not so low as in 1842, when it was at 37°·00. The latter part of the month was uncommonly cold; from the twentieth to the thirtieth day the temperature was many degrees below freezing every morning but one, on the twentieth it was at 12°, and on the 26th at 10°·above zero; while a little west of Davenport in Iowa it was at ten below. On the 19th snow fell to the depth of two inches, greatly increasing the cold, as it seldom or never becomes excessive when the ground is bare. By the 25th of the month large sheets of ice had formed in the Ohio, and in two days after was so full of it as much to impede navigation. One steamboat was sunk a few miles below Marietta, the hull being cut through by the ice. By the 26th the Muskingum river was frozen over above town, but opened again with the mild weather early in December.

The effects of this early severe cold was very injurious to the potatoes, many acres of which yet remained in the ground, and were in a great measure destroyed; others already harvested were left in the open fields in barrels, and suffered nearly as much as those in the earth, and many thousands of bushels were lost in this way. The continual wet weather in October had retarded the harvesting of this crop to a later period than usual; though we seldom expect cold weather until the month of December. Much of the corn crop was destroyed by the effects of the cold and the wet weather that followed; and although cut up and placed in shocks in the usual manner, yet the hard freezing injured the immature grains, and with the warm wet weather which followed in December, caused it to mould and rot, rendering worthless thousands of bushels all over the State of Ohio.

Floral Calendar.—March 3d, Bluebird seen; 13th, Pewee heard; 21st, Garden Crocus in bloom; 23d, Hepatica triloba; 25th, Forsythia viridissima opening its blossoms; 30th, Sugar tree; 31st, Red Elm, Early Hyacinth. April 4th, Forsythia in full bloom, much killed by the cold in January; 13th, hard frost, thermometer 22°; 16th, Crown Imperial, two feet high; 17th, hard frost, thermometer 23°; 24th, Crown Imperial in full bloom; 27th, Sanguinaria Canadensis; 30th, Peach, in warm exposures, begins to open. May 2nd, Peach in full bloom; 3d,

Pear and Cherry; 4th, Pyrus Japonica, this Chinese flowering shrub often opens early in April, Spirea Prunifolia; 6th, June-berry; 9th, Apple in full bloom; 10th, Early tulips; 11th, Ranunculus and Uvularia; 14th, Black Cohusk and Birthwort; 15th, Harebell; 17th, Judas tree; 21st, Tree peony, var. papaveracea; 23d, Crab apple and Quince; 24th, Black Haw; 25th, White Oak, Horse-chesnut, Cornus Florida, Yellow moccasin flower; 27th, Snow-ball, Rose-colored Peony. June 4th, yellow Harrison rose, Magnolia tripetala, Purple peony, White peony; 12th, Fragrant peony; 13th, Strawberry ripe; 14th, Syringa Philad., the fragrant variety was killed by the winter; 18th, Catawba grape. July 10th, Catalpa in bloom, Red raspberry ripe; 14th, Wheat harvest begins, late by two weeks; 21st, Blackberry ripe.

Marietta, Ohio, January 5th, 1858.

ART. XXXI.—*On the Extraction of Salts from Sea-water;* by T. STERRY HUNT, of the Geological Commission of Canada.*

THE manufacture of salt from the waters of the ocean has from an early period been an important branch of industry for the south of Europe. Without reverting to high antiquity, we may cite the salines of Venice, to which that republic owed the commencement of its greatness and its wealth. The lagoons which surrounded that city were enclosed and set apart for the breeding of fish and for the manufacture of salt. Making a monopoly of this staple of life, the policy of Venice was to obtain possession of all those salines which could compete with her, and we find the Venetians destroying such as they could not make use of, and exacting from the neighboring princes, treaties to the effect that they would not re-establish the suppressed salines. It was only two or three centuries later that this powerful republic ordered, in the interest of her commerce, the suppression of the salines of her own lagoons, and augmented the produce of those of Istria and of the Grecian Islands, which had become her's by right of conquest, still retaining in her own hands the trade in salt for all southern Europe. But with the downfall of Venetian power, we find the salines of Provence and Languedoc growing into importance, while those of Venice had fallen into decay, so that when the Emperor Napoleon I. created the kingdom of Italy, he had recourse to a French engineer from Marseilles to re-establish the salines of Venice, which are now once more organized on a vast scale.

* Extracted by the author from the *Report of Progress of the Geological Survey of Canada* for 1853-56, pp. 404-417, where it forms part of a report on the Industrial Exhibition at Paris in 1855.

It is however in France, and especially upon the shores of the Mediterranean, that we shall find the most extensive salines, and the most intelligent system of working these great sources of national wealth. On the western coast of France, the salt marshes of Brittany and La Vendée are wrought to a considerable extent, but the cool, moist and rainy climate of these regions is much less favorable to this industry than that of the southern shores of the empire, where dry and hot summers offer great facilities for the evaporation of the sea-water, which is effected in all the salines of which we have spoken, by the sun and wind, without artificial heat.

The salt works of the Lake of Berre, near Marseilles, were those whose products attracted the most attention at the Exhibition, not only on account of the excellent method there pursued for the manufacture of sea-salt, but from the fact that the important processes of Mr. Balard for the extraction of potash, sulphates and other valuable materials from the mother liquors, are there applied on a large scale. Having had occasion to examine carefully these products in the course of my duties as Juror at the Exhibition, and having afterwards visited the saline of Berre, I propose to give here some account of its construction and mode of operation, as well as of the method employed for the working of the mother liquors. I have to express my great obligations to my distinguished colleague, Mr. Balard, of the Academy of Sciences, who most kindly furnished me with every information respecting the processes of his invention which are there applied, and also to Mr. Agard, the enlightened and scientific director of the saline.

The first condition for the establishment of a salt work is a low, broad, level ground on the border of the sea, which can be protected by dykes from the action of the tides, and as these are considerable on the Atlantic coast and insignificant in the Mediterranean, the arrangements required in the two regions are somewhat different. In both cases, however, the high tides are taken advantage of to fill large and shallow basins with the sea water, which there deposits its sediments, becomes warmed by the sun's rays and begins to evaporate. From these reservoirs it is led by a canal to a series of basins from ten to sixteen inches in depth, through which it passes successively, and where by the action of the sun and wind the water is rapidly evaporated, and deposits its lime in the form of sulphate. It then passes to another series of smaller basins, where the evaporation is carried to such a point that the water becomes a saturated brine, when its volume being greatly diminished, it is transferred to still smaller shallow basins called *salting tables*, where the salt is to be deposited. In the salines of the Atlantic coast, the different basins are nearly on the same plane, and the water flows from

one series to the other as its level is reduced by evaporation. In the large establishments of the Mediterranean, the system is different; the basins are constructed at different levels, and the waters having passed through one series, are raised by wooden tympans or drums from eight to sixteen feet in diameter, (moved by steam or horse power,) and conducted into the other basins. There differences of level establish a constant current, and in this way greatly promote the evaporation.

But in whatever manner the process is conducted, the concentrated brines, marking 25° of Beaumé's areometer, are finally conducted to the salting tables, where they begin to deposit their salt in the form of crystalline crusts, which are either collected with rakes as soon as they form, or as at Berre, allowed to accumulate at the bottom, until they form masses six or eight inches in thickness. The concentration of the brines must be carefully watched, and their density never allowed to exceed 28°·5, otherwise a deposit of sulphate of magnesia would be formed, rendering the sea-salt impure. The mother liquors, as they are called, are run off so soon as they have reached the above density, and reserved for operations to be detailed further on. When the salt has attained a sufficient thickness, it is broken up and piled upon the sides of the basins in large pyramids, which are covered with clay on the western coast of France, but left unprotected during the summer season, in the dry climate of the south. In these heaps, the salt undergoes a process of purification; the moisture from the clay or from occasional rains penetrates slowly through the mass, removing the more soluble foreign matters, and leaving the salt much purer than before. In the south, it is taken directly from these heaps and sent into the market, but in the less favorable conditions presented on the western coast, the thin layers of salt there collected are more or less soiled with earthy matters, and for many uses require a process of refining before they are brought into commerce. For this purpose two methods are employed; the one consists in simply washing the crude salt with a concentrated brine, which removes the foreign salts, and a large portion of the earthy impurities. The other more perfect, but more costly process, consists in dissolving the impure salt in water, and adding a little lime to precipitate the salts of magnesia always present, after which the filtered brine is rapidly boiled down, when a fine-grained salt separates, or is more slowly evaporated to obtain the large-grained cubic salt which is used in the salting of provisions. The masses of coarsely crystalline salt from the salines of the south have no need of these refining processes.

In practice, the evaporation of the brines for sea-salt at Berre is carried as far as 32°, and the salt separated into three qualities Between 25° and 26° the brine deposits one-fourth of its salt

which is kept apart on account of its great purity, and sold at a higher price than the rest. In passing from a density of 26° to 28°·5, sixty per cent more of salt of second quality are deposited, and from this point to 32° the remaining fifteen per cent are obtained, somewhat impure and deliquescent from the magnesian salts which it contains, but preferred for the salting of fish, on account of its tendency to keep them moist. The average price of the salt at the salines is one franc for 100 kilograms (220 pounds avoirdupois), while the impost upon it was, until recently, thirty times that sum, and is even now ten francs the 100 kilograms.

The waters of the Mediterranean contain, according to the analysis of Usiglio, about three per cent of common salt, while those of the Atlantic contain from 2·5 to 2·7 per cent. In the waters of the Mediterranean there are besides, about 0·8 per cent of sulphates and chlorids of calcium, magnesium and potassium. The quantity of water which it is necessary to evaporate in order to obtain a small amount of salt, thus appears to be very great, but under favorable circumstances this is a small consideration, as will appear from the following fact. The saline of Berre is situated upon a small lake, communicating with the ocean, but fed by streams of fresh water, so that while the waters of the open sea have a density of 3°·5, those of the lake have only 1°·5, or scarcely half the strength of sea water. Nevertheless the advantages of the position offered by the shores of the lake for the establishment of a saline, are sufficient to compensate for the deficiency of salt in the water, and to make of Berre one of the most flourishing salines of the south of France. The evaporating surfaces here cover 3,300,000 square metres, equal to 815 English acres; of this area, one-tenth is occupied with the salting tables, but with sea-water, where less evaporation is required to bring the brine to the crystallizing point, one-sixth of the area would be thus occupied. The amount of salt annually produced at the saline of Berre is 20,000,000 kilograms.

Owing to the dilution of the water of the lake of Berre, the proportion of salt there manufactured is small, when we consider the area, and compare the produce with that of other salines where pure sea-water is evaporated. According to Mr. Balard, 2,000,000 square metres may yield 20,000,000 kilograms annually; and Mr. Payen states that the same amount of salt is produced at Baynas from a superficies of 1,500,000 metres. As a cubic metre of sea-water contains about 25 kilograms of salt, the evaporation required to produce the above amount corresponds to 800,000 cubic metres, equal in the second estimate given above, to a layer of water 0·40 metre, or 15¾ English inches in thickness.

The plan hitherto adopted in the salines of the European coasts, has been to commence the evaporation of the sea-water with the spring time of each year; in this way some three or four months elapsed before a sufficiently large amount of strong brine was accumulated to enable the manufacturer to commence the deposition of salt on the salting tables, and as this latter operation can only be carried on in fine weather, the rainy season of autumn soon came to interrupt the process, so that during a large part of the year the labors of the salines were suspended. The enlightened director of the works of Berre, M. Felicien Agard, has however introduced a very important improvement, in the management of the salines, by means of which he carries on the works throughout the whole year, and is enabled to increase the produce by 50 per cent. During the months of the autumn, the evaporation, which is still carried on, though more slowly, enables him to obtain brines marking 7°, 10°, and even 20°. These are stored away in large pits, where the depth of liquid being considerable, the diluting effect of the spring rains is but little felt, and at the commencement of the warm season these brines are raised into the evaporating basins, so that the summer's labors are commenced with concentrated liquors, and the salt is all harvested in the months of August and September.

In selecting the site for a saline it is of great importance to choose a clayey soil, an earth of this character being required to render the basins and dykes impervious to water. In the saline of Berre, a coriaceous fungous plant, to which botanists have given the name of *Microcoleus Corium*, was observed to vegetate upon the bottom of the basins, and this being carefully protected, has finished by covering the clay with a layer like felt, which protects the salt from contamination by the earth, and enables it to be collected in a state of great purity.

The conditions of exposure to sun and wind offered by the locality chosen for a saline are also to be carefully considered, for upon these will of course greatly depend the rapidity of evaporation. The salines of the lagoons of Venice, to which we have already alluded, have recently been reorganized by Baron S. M. Rothschild and Mr. Charles Astric, and cover an area nearly twice that of Berre. The tides of the Adriatic are considerable, and from the lowness of the ground, the labor of constructing the basins and dykes could only be carried on at low water. The moist and rainy climate of Venice also offers serious obstacles to the manufacture of salt; to overcome these, two plans are adopted. The salting tables are so arranged that in case of heavy rains, the concentrated brines can be rapidly run off into deep reservoirs, while other reservoirs of saturated brine at higher levels serve not only to feed the salting tables, but to cover with a thick layer those tables which may contain

a large amount of salt, and thus protect them from the atmospheric waters.

We may mention here a process which, although unknown in France, is applied in Russia and on the borders of the White Sea, and may, perhaps, be advantageously employed on our own shores. It consists in applying the cold of winter to the concentration of the sea-water. At a low temperature a large quantity of ice separates, but all the saline matters rest in the liquid portions, so that by separating the ice a concentrated brine is obtained, which may afterwards be evaporated by the summer's sun or by artificial heat.

Treatment of the Bittern or Mother Liquor.—The waters, which have reached a density of 32° in the salting tables, have already deposited the greater part of their common salt, and now contain a large amount of sulphate and hydrochlorate of magnesia, together with a portion of chlorid of potassium. The admirable researches of Mr. Balard have taught us to extract from these mother liquors, sulphate of soda, and salts of magnesia and potash, so that although formerly rejected as worthless, these liquors are now almost as valuable as the salt of which they are the residue.

The production of sulphate of soda, which is directly employed in the manufacture of glass, and as a manure, and still more largely as a material for the fabrication of carbonate of soda, is the most important object of the working of the mother liquors. Immense quantities of sulphate of soda are now prepared in France and England by decomposing sea-salt with sulphuric acid, which is manufactured with sulphur obtained chiefly from foreign sources. In view of this immense consumption of sulphur, it becomes important, especially in time of war, when this substance is required for the fabrication of gunpowder, to find some source of sulphate of soda other than the decomposition of sea-salt by sulphuric acid. This process is besides objectionable from the vast amount of hydrochloric acid disengaged, which in most localities cannot be entirely consumed, and is very pernicious to both animal and vegetable life in the vicinity.

It had already been observed that under certain conditions the reaction between sulphate of magnesia and chlorid of sodium could give rise to sulphate of soda; and Mr. Balard has shown that by taking advantage of this decomposition, the sulphate of soda can be advantageously prepared from the bittern of the salting tables.

When the liquors of 32° are evaporated by the summer's heat, they deposit during the day a portion of common salt; but the coolness of the nights causes the separation of crystals of sulphate of magnesia, and the quantity of this latter salt goes on increasing as the evaporation advances toward 35°. This mix-

ture of salts (A) is carefully collected, and reserved for the manufacture of the sulphate of soda.

When the bittern at 35° is still further evaporated by the heat of the sun, it deposits a mixture which is called *sel d'été*, and contains a large amount of potash. By a second crystallization of this product, a double sulphate of potash and magnesia is obtained, which holds 24 per cent of potash; but this mode of treating the mother liquors of 35° is less advantageous than the following, which is now adopted. The liquors are placed in large basins and preserved until the first frosts, when, at a temperature of 35° or 40° Fahrenheit, they deposit the greater part of their sulphate of magnesia in large crystals. This sulphate is either sold to the apothecaries, or used to prepare sulphate of soda by the process about to be described. When the sulphate of magnesia has been thus separated, the liquid is run off into large reservoirs, and preserved until the next summer, when it is again evaporated in shallow basins by the sun's rays. It now deposits a large amount of a fine granular salt, which is a double chlorid of potassium and magnesium. This double salt can only be crystallized from solutions containing a large quantity of chlorid of magnesium, and when re-dissolved in pure water gives pure chlorid of potassium by evaporation. The double chlorid is raked up from the tables and placed in piles on the earth, where the moisture causes the salt to decompose; the magnesian salt deliquescing, drains off, and the chlorid of potassium remains behind.

The mother liquors, having acquired a density of 38°, have deposited all their potash, and are now evaporated by artificial heat to 44°; during this evaporation they still deposit a portion of common salt mixed with sulphate of magnesia (B), and on cooling, the liquid becomes a solid mass of hydrated chlorid of magnesium, which may be employed to furnish caustic and carbonated magnesia by decomposition. When calcined in a current of steam, it is completely decomposed into hydrochloric acid and an impure magnesia, still containing some sulphates and chlorids, which may be removed by water.

By mingling in proper proportions the solution of chlorid of magnesium at 44° with brine at 24°, nearly the whole of the sea-salt is precipitated in the form of minute crystals of great pureness and beauty; the mother liquors are then removed by washing with a saturated brine, and in this way a very fine quality of table salt may be advantageously manufactured.

During these successive concentrations, the volume of the water has become greatly diminished. 10,000 gallons of sea-water reduced to 25°, (the point at which it begins to deposit salt,) measure only 935 gallons; at 30°, 200 gallons; at 31°, 50 gallons; and at 34°, are reduced to a volume of only 30 gallons.

Preparation of Sulphate of Soda.—For this process the cold of autumn and winter is required. The mixtures of sea-salt and sulphate of magnesia, (A and B,) together with the pure sulphate of magnesia obtained from the mother liquors at 82°, are dissolved in water heated to 95° F., with the addition of such a quantity of common salt as shall make the proportions of the two salts equal to 90 parts of chlorid of sodium to 60 of anhydrous sulphate of magnesia. The warm saturated solution is exposed in shallow basins to a cold of 32° F., when it deposits 120 parts of hydrated sulphate of soda, equal to 54 of anhydrous sulphate, or three-fourths of the sulphuric acid of the mixture. In theory, about equal weights of the two salts are necessary for their mutual decomposition, but an excess of common salt diminishes the solubility of the sulphate of soda, and thus augments the product. From the residual liquid, which contains chlorid of magnesium mixed with common salt and a portion of sulphate of magnesia, the latter salts may be separated by evaporation. The sulphate of soda is converted into carbonate of soda by the usual process of calcination with carbonate of lime and coal.

The Potash Salts.—The chlorid of potassium obtained by the process already indicated, is decomposed by sulphuric acid, and the resulting sulphate at once converted into carbonate of potash by a process similar to that employed for the manufacture of carbonate of soda. The carbonate of potash thus prepared is free from sulphate and chlorid, as well as from silica and alumina, and those metallic impurities which, like iron and manganese, are always present in the salt obtained from wood-ashes, and render the potashes of America and Russia unfit for the fabrication of fine crystal glass. The double sulphate of potash and magnesia may be at once decomposed like the sulphate of potash, by limestone and coal, and both it and the chlorid may be directly employed in the fabrication of potash-alum, a salt which contains nearly ten per cent potash, and of which five thousand tons are annually manufactured in France. The high price of the salts of potash has led the manufacturers of alum, to replace this alkali wholly or in part by ammonia, but the potash salts from sea-water will furnish potash so cheaply as to render the use of ammonia no longer advantageous.

The greater part of chlorid of potassium as yet produced in the salines in the south of France is now, however, employed chiefly in the Imperial manufactories of saltpetre or nitrate of potash. The nitrate of soda brought in great quantities from South America, is decomposed by chlorid of potassium, yielding common salt and pure nitrate of potash for the fabrication of gunpowder.

Yield of the Mother Liquors.—According to a calculation of Mr. Balard the proportion of sulphates in sea-water corresponds to a

quantity of anhydrous sulphate of soda equal to one-eighth that of the common salt, but on a large scale the whole of this cannot be economically extracted: the saline of Baynas yields annually besides 20,000 tons of sea-salt, 1,550 tons of dried sulphate of soda, or 7·75 per cent, instead of the 12·50 per cent indicated by theory. Estimating the yield at 7·0 per cent the cost of the sulphate according to Payen, will be 30 francs the ton, which will make the cost of the crude carbonate of soda 50 francs, while it brings in France from 80 to 120 francs the ton.

The amount of chlorid of potassium obtained is equal to one-hundredth, or to 200 tons for the above amount of sea-salt, and the value of this salt is 360 francs the ton. By its decomposition it will yield 185 tons of pure carbonate of potash, which sells for 1000 or 1100 francs the ton. Thus it appears that for 20,000 tons of sea-salt, worth at ten francs the ton, 200,000 francs, there is obtained chlorid of potassium for the value of 72,000 francs. The potash, being a secondary product from the residues of the processes for sea-salt and sulphate of soda, is obtained almost without additional cost. It has been shown by careful calculations that the sulphate of soda and the potash from the waters of the Mediterranean, will alone repay the expense of extraction, the sea-salt first deposited being redissolved and carried back to the ocean. A powerful company is now erecting works on a great scale in the vicinity of Marseilles, where the marshes of the Camargue offer a great extent of waste lands, valueless for cultivation, but well adapted for this manufacture. Here it is proposed to evaporate the sea-water solely for the sake of the sulphates, the potash and the magnesia, which it contains. Basins which are already covered with a layer of sea-salt, are very advantageously employed for the evaporation of the mother liquors, from the ease with which the potash and magnesia salts may be collected from it in a state of purity.

The amount of salt produced in France in 1847 was about 570,000 tons, of which 263,000 were from the salt-marshes of the Mediterranean, 231,000 from those of the western coast, and 76,000 from salt springs and a mine of rock salt; there were employed in these 16,650 workmen. If we estimate the produce of the salt marshes in round numbers at 500,000 tons, the amount of chlorid of potassium to be obtained from the mother liquors at one per cent, will be 5000 tons, and that of the sulphate of soda at 7 per cent will be 35,000 tons. The amount of sulphate of soda annually manufactured in France is 65,000 tons, requiring for this purpose 54,000 tons of sea-salt, and nearly 14,000 tons of sulphur, which is completely lost in the manufacture of carbonate of soda.* If now the mother liquors, from an

* The soda manufactory of Chaunay, established in connection with the glass works of St. Gobain, consumes above 5,000 tons of sulphur yearly, and the immense

area twice as great as is now occupied by all the salines in France, were wrought with the same results as at Baynas, they would yield, besides 70,000 tons of sulphate of soda, or more than is required for the wants of the country, 10,000 tons of chlorid of potassium, equal to 9,250 tons of pure carbonate of potash, a quantity far greater than is consumed in France, and would enable her to export potash salts. According to Mr. Balard the consumption of potash in France amounted in 1848 to 5,000 tons, of which 3,000 were imported, and 1,000 tons extracted from the refuse of the beet-root employed in the manufacture of sugar.

The production of the two alkalies, potash and soda, offers some very interesting relations. Previous to the year 1792, soda was obtained only by the incineration of sea-weed and maritime plants; but it was at that epoch, when France was at war with the whole of Europe, that her necessities led to the discovery of a mode of extracting soda from sea-salt. Obliged for the purposes of war to employ all the potash which the country could produce, for the manufacture of saltpetre, it became necessary for the fabrication of soaps and glass to replace this alkali by soda, and therefore to devise some more abundant source of it that was afforded by sea-weed. It was then that the government having offered a prize for the most advantageous method of extracting the soda from sea-salt, Leblanc proposed the process above alluded to, which consists in converting the chlorid of sodium into sulphate, and decomposing this salt by calcining it with a proper mixture of ground limestone and coal, thus producing carbonate of soda and an insoluble oxy-sulphuret of calcium. This remarkable process, perfect from its infancy, has now been adopted throughout the world, "and those who thought to annihilate the industry of France were soon obliged to borrow from her those great resources which French science had invented." (*Payen*, *Chimie Industrielle*, p. 209.)

Soda has now replaced potash to a very great extent in all those arts where it can without prejudice be substituted for the latter; potash is however indispensable for the manufacture of fine crystal and Bohemian glass, for the fabrication of saltpetre, as well as for the preparation of various other salts employed in the arts. The country people in France, having been accustomed to employ the crude American potash for the bleaching of linen, were unwilling to make use of the purer soda-ash, and the result is that a great part of what is sold as American potash in France,

establishment of Tennant, at St. Rollox, near Glasgow, employs annually 17,000 tons of salt, 5,550 of sulphur and 4,500 tons of oxyd of manganese. It produced in 1854, 12,000 tons of soda-ash, 7,000 of crystallized carbonate of soda, besides 7,000 tons of chlorid of lime, prepared with the chlorine obtained by decomposing the waste hydrochloric acid from the soda-process by the oxyd of manganese. The cost of sulphur in England in 1854 was about twenty-five dollars the ton.

is nothing more than an impure caustic soda, colored red with sub-oxyd of copper, and fused with an admixture of common salt, which serves to reduce its strength, and give it the aspect of the crude potash of this country.

But notwithstanding the soda from sea-salt is now replacing potash to so large an extent, the supply of this alkali is scarcely adequate to the demand, and the consequence is that while the price of soda has greatly diminished, that of potash has of late years considerably augmented, and it has even been proposed to extract this alkali from feldspar and granitic rocks, by processes which can hardly prove remunerative. The rapid destruction of the forests before the advancing colonization of this continent, threatens at no distant day to diminish greatly the supplies of this as yet important production of our country, and it was therefore a problem of no small importance for the industrial science of the future, to discover an economical and unfailing source of potash. The new process of Mr. Balard appears to fulfill the conditions required, and will, for the time to come, render the arts independent of the supplies derived from our forests.

Art. XXXII.—*Contributions to Analytical Chemistry;* by Henry Wurtz, of New York City.

Investigation of the action of nitric acid upon the metallic chlorids.

During the spring of 1850, while attempting to devise a method for the easy separation of magnesia from the alkalies, in the laboratory of Dr. Wolcott Gibbs in New York City, I found that the chlorids of magnesium and the alkali-metals were readily and perfectly decomposed by mixture with an excess of nitric acid and subsequent evaporation. Intending to investigate the subject thoroughly, and to make it the basis of a new method of separation, I did not publish the observation at the time, and it is but recently that I have had an opportunity to pursue the path of investigation thus indicated.

Subsequently, in the American Journal of Science for January, 1853, Professor J. Lawrence Smith of Louisville announced his discovery of the complete decomposition of chlorid of ammonium by evaporation of its solution with excess of nitric acid, and followed shortly with another paper,* in which he showed that the chlorids of potassium and sodium are also decomposed by the same treatment, and converted into nitrates. My friend Dr. Gibbs, remembering, although not perfectly it seems, my own previous experiments in his laboratory, was kind enough to

* Am. Jour. Science for Nov. 1853, vol. xvi, p. 373.

append, without my knowledge, a note to Dr. Smith's paper, which reads as follows.

"*Note to Dr. Smith's paper on the decomposition of the chlorids by nitric acid.*—Dr. Smith's observation that the alkaline chlorids are decomposed by heating and evaporating with nitric acid is not new, although I am not aware that the fact has ever been published. Mr. H. Wurtz made experiments on the subject in my laboratory *two years since*, and obtained the same results as Dr. Smith. The complete decomposition of chlorid of magnesium by evaporation with nitric acid, was also observed in the laboratory of the late Prof. Norton, *a year or two I believe before* Mr. Wurtz studied the subject. The alkaline nitrates are easily converted into chlorids, by boiling them with an excess of chlorhydric acid, in presence of any metallic oxyd having a strong affinity for oxygen. I employ the protochlorid of tin for this purpose, and when the reaction is over, and gas (nitrous oxyd) is no longer evolved, a current of sulphydric acid gas removes the tin, and the filtrate contains only the alkaline chlorid and free chlorhydric acid.—W. G."*

I have introduced the italics for the purpose of directing attention to what is apparently a misremembrance of date on the part of Dr. Gibbs; my experiments in his laboratory having been made, as above stated, about *three years and a half* previously, and so far as I can ascertain, no experiments having been made in Professor Norton's laboratory. Although the matter is of no great importance, it still seems right that the discovery of the complete decomposition of chlorid of magnesium by nitric acid, which was the starting point of the following investigation, and which appears to have been first made by me, should not go without a claimant.

With this brief historical introduction I will proceed to present the results of my experiments, the object of which has been to ascertain the character of the action of nitric acid upon *all* the metallic chlorids, in order not only to complete our knowledge of this class of reactions, and enable us to generalize them, but also to furnish facts which may reasonably be hoped to have application in analysis; of which the separation of magnesia from the alkalies already promises to be one instance.†

My experiments were made generally upon each chlorid both in the crystallized or dry state and in the state of solution, a mode of proceeding equivalent in many cases only to the determination of the action of the nitric acid in the concentrated and

* Am. Jour. Science [2], xvi, 416.

† It would be wrong for me not to acknowledge here my indebtedness to some of my friends, especially to Messrs T. Sterry Hunt, George J. Brush and James R. Brant, for the very generous manner in which they have supplied me with preparations of some of the *rare metals*, needed to render my investigation complete.—H. W.

dilute conditions. The acid chiefly operated with was chemically pure and of specific gravity $=1{\cdot}29$, but in some cases a fuming acid which had been rectified and of spec. grav. $=1{\cdot}43$ was made use of.

1. *The Alkali-metals, Potassium, Sodium and Lithium.*—Dr. J. Lawrence Smith, in the memoir of November, 1853, before alluded to, mentions his having obtained the complete decomposition of the chlorids of sodium and potassium by nitric acid. It is by no means necessary, however, as stated there by Dr. Smith, that the nitric acid should be "boiled gently" with the chlorids; for a mere evaporation to dryness without ebullition effects a complete reaction, and if the nitric acid be in sufficient excess, and the chlorids are in solution, or *become dissolved* during the process, one evaporation is enough. These facts are of evident importance in any proposed analytical applications.

Pure chlorid of lithium* behaves with nitric acid precisely like the chlorids of potassium and sodium.

Pure crystals of chlorid of sodium being heated gradually with an excess of nitric acid of spec. grav. $=1{\cdot}29$, (by immersing the beaker in water and applying heat to the latter), the following appearances were observed.

At about 75° C., small bubbles of gas were evolved, the evolution becoming very copious at 100° C., and the salt rapidly dissolving to a clear yellow liquid. On cooling, the evolution ceased again at 75° C., and on further cooling small granular crystals separated plentifully, which were washed with strong alcohol, and found to contain but a trace of chlorine, and to deflagrate with charcoal, being in fact *nitrate of soda.* A further quantity of nitrate of soda was obtained by evaporating and adding alcohol to the solution. I may remark here that Gmelin states with regard to *chlorid of potassium*† that "aqueous (wasserhaltige) nitric acid forms with it a potash salt with separation of chlorohydric acid." Neither the authority for the statement, nor the *temperature* at which the result was obtained, are given.

The gas evolved during the reaction is *brown-yellow,* having none of the reddish tinge of nitrous acid, nor perceptibly of the feeble greenish tinge of chlorine. Attemps made to isolate it by collection over hot water failed, owing to its very rapid and almost total absorption by the latter. No reasonable doubt can exist, however, that this brown-yellow gas is the same as that evolved by heat from *aqua regia,* in which Gay-Lussac found, together with chlorine, his chloronitrous and hypochloronitric acids, NO^2Cl and NO^2Cl^2, especially when we take into consid-

* Two preparations were operated upon, made from specimens of the carbonate presented to me by Messrs. Hunt and Brush, one of which was found to be pure, and the other contained only a little carbonate of ammonia.

† Handbuch der Chemie, ii, 56.

eration that, according to Gay-Lussac, the products in the earlier stages of the reaction are chiefly chlorine and NO^2Cl^2, the latter consisting of equal volumes of nitric oxyd and chlorine, while E. Davy,* in an earlier examination of this very case, namely the action of nitric acid upon chlorid of sodium, actually found a gaseous product composed of nitric oxyd and chlorine in equal volumes. The *color* of the evolved gas moreover corresponds to that attributed by Gay-Lussac to the gas evolved by *aqua regia*, namely brownish-yellow, and I find, upon comparison of the two gaseous mixtures, that the only difference distinguishable by the eye is a greater depth of color on the part of that evolved by the chlorid of sodium. In order to ascertain whether the gas contained either of the lower oxyds of nitrogen, a large quantity of it was passed into a receiver over hot water, and by this means was finally obtained a small portion which was not absorbed by the water nor by potash. Transferred to a tube this was found to support combustion, and even to produce an increased glow upon a glowing splinter of charcoal introduced into it, whilst no red color was produced by admixture with air; from which is of course to be inferred the presence of nitrous and the absence of nitric oxyd.

2. *Ammonium.*—In Dr. Smith's investigation of the action of nitric acid upon sal-ammoniac, he has shown that the chief product of this reaction is nitrous oxyd.† On his results he has founded his highly important method of removing sal-ammoniac in the process of analysis, a method which I have frequently used and consider to be of high value. In fact if pure sal-ammoniac and pure nitric acid be mixed together and evaporated on the sand-bath (much below ebullition), in most cases no residue whatever is left. Cases however have occurred to me in which a quantity of *nitrate of ammonia* was formed, that proved more troublesome to get rid of than the original sal-ammoniac. This may have depended on the relative proportions of acid and chlorid in the mixture, but of this point I have made no examination.‡

* Liebig und Kopp's Jahresb. für 1847–48, p. 387.

† Am. Jour. Science, [2], xv, 240, (note).

‡ With regard to the character of the reaction in this decomposition, Dr. S., after recounting the results of some partial experiments to determine the nature of the products, remarks as follows: "The character of the decomposition which takes place, is somewhat curious and unexpected. At first I supposed that the decomposition resulted in the formation of equal volumes of NO, Cl, and N, but it appears that such is not the case, and that all but a very small portion of the ammonia with its equivalent of nitric acid is converted into NO; the liberated hydrochloric acid mixing with the excess of nitric acid; a little of the sal-ammoniac and nitric acid does undergo the decomposition first supposed, and in this way only can the small amounts of chlorine and nitrogen be accounted for."

Upon considering this subject from every point of view at present available, I am led to ask the question whether *all* the reactions of this class, in which nitric acid comes into contact with another substance containing hydrogen or an electro-positive

3. *Hydrogen.*—Reasoning from the analogy of hydrogen to the alkali-metals, chlorohydric acid ought to comport itself with nitric acid like chlorid of sodium. In fact the method so long in use of freeing nitric acid from chlorohydric, by distillation and rejection of the first portion, which contains all the chlorine, plainly depends upon this relation; although of course, the true theory of the method could not be understood until Gay-Lussac had published his elegant discoveries regarding *aqua regia.*

Some *aqua regia* containing excess of nitric acid was evaporated on the sand-bath until the evolution of chlorine and Gay-Lussac's acids had ceased, and the liquid, at first highly colored, had become colorless. No trace of chlorine could any longer be found in it.

4. *Magnesium.*—A strong solution of pure chlorid of magnesium mixed with pure nitric acid of sp. gr. 1·29 and evaporated upon the sand-bath, left a residue in which chlorine was still

metal under the influence of heat, are not occasioned simply and solely by the combination of such hydrogen or metal with the oxygen of the nitric acid to form water. Thus in the formation of NO^2Cl^2 from *aqua regia*, according to Gay-Lussac the reaction is

$$3HCl+NO^5=3HO+Cl+NO^2Cl^2;$$

and in the formation of NO^2Cl, $3HCl+NO^5=3HO+Cl^2+NO^2Cl$.

Look also at Maumené's reaction between sal-ammoniac and nitrate of ammonia (Liebig and Kopp's Jahresbericht for 1851, p. 321; Am. Jour. Science, [2], xiii, 412,) in which are obtained five volumes of nitrogen and one of chlorine,

$$NH^4Cl+2(NH^4O,NO^5)=12HO+Cl+5N;$$

and at the familiar equation representing the formation of laughing gas from nitrate of ammonia,

$$3(NH^4O,NO^5)=12HO+6NO.$$

I might probably multiply examples, but these will serve to illustrate my meaning. It is obvious at a glance that in all the above cases all the hydrogen present becomes water at the expense of the oxygen of the nitric acid, and the other elements arrange themselves according to their relations at the temperature. Now on this hypothesis the action of nitric acid upon the chlorids of the alkali-metals, for instance that upon chlorid of sodium, the products of which, according to E. Davy are chlorine and NO^2Cl^2 (or something having the same equivalent constitution), would be

$$3NaCl+4NO^5=3(NaO, NO^5)+Cl+NO^2Cl^2;$$

and that of nitric acid upon sal-ammoniac would be

$$3NH^4Cl+4NO^5=12HO+Cl+NO^2Cl^2+6NO;$$

two equations which present striking analogies. Nor is it difficult to reconcile the results of Dr. Smith with this last equation. The gaseous mixture which he examined was collected over hot water, which would absorb the NO^2Cl^2, together with a portion of the chlorine, and the remaining gas would evidently be nearly all NO.

The verification of this hypothesis seems to me a subject worthy of attention, and will be kept in view throughout the present investigation, as this may develop facts throwing light upon these reactions.

I may add here that on careful comparison of the color of the gas evolved by nitric acid in its action upon sal-ammoniac with that of the gas evolved by *aqua regia.* the two appeared, not only to my own eyes but to those of other persons, to be the same, namely a mixture of yellow and brown, differing merely in *shade*, the tint in the case of sal-ammoniac being much lighter.

easily detected, but on moistening the residue with the same nitric acid and reëvaporating, no trace of chlorine was found in the second residue. With crystallized chlorid of magnesium the same results were obtained. Two evaporations with excess of acid seem to be sufficient under ordinary circumstances to complete the decomposition, and in favorable conditions it may be effected by one. Thus pure crystals of the chlorid $MgCl+6HO$, dried by pressure between folds of paper, were heated with nitric acid of sp. gr. 1·43. They quickly dissolved to a clear solution, which when evaporated to dryness left a residue containing no trace of chlorine.

Pure crystals of chlorid of magnesium heated with excess of nitric acid of sp. gr. 1·29 began to give off gas in minute bubbles at 60° C., quickly dissolving to a clear yellow solution. The evolution of gas however was not copious even at 100° C.; but on heating a little above this temperature, it became rapid and violent, the color of the gas given off being a brownish yellow. On gradual cooling, the gas ceased to be formed at about 75° C. As in the case of chlorid of sodium, an attempt was made to collect the gas over hot water, which failed for the same reason as in that case. On cooling to the temperature of the air, no change took place in the liquid, and none on the addition of alcohol in large quantity.

5. *Calcium.*—Experiments were made with a concentrated solution of the pure chlorid, with the crystals, and with the anhydrous salt. In each case, one evaporation expelled every trace of chlorine.

6. *Strontium.*—Parallel experiments, as in the case of calcium, were made with this chlorid in solution, crystallized and dry, and with similar results.

7. *Barium.*—With the chlorid in solution, crystallized, and dry, results similar to those under (5) and (6) were obtained. Chlorid of barium in the *solid* form appeared however to be much more difficult of decomposition than the other salts of this group, requiring generally one or more repetitions of the evaporation with nitric acid to convert it entirely into nitrate, although a dilute solution yielded with the greatest readiness. This fact was at first explained upon the belief commonly entertained that chlorid of barium is very difficult of solution in nitric acid, a belief founded upon the fact that when a strong solution of this chlorid is added to nitric acid, unless the latter be very dilute, a precipitate appears, which has been supposed to consist of chlorid of barium. Thus H. Rose says:* "When to a solution of a salt which is to be examined (for sulphuric acid) chlorohydric or nitric acid has been added, it must still be remarked that upon

* Ausführliches Handbuch der analytischen Chemie, i, 485.

then adding a concentrated solution of chlorid of barium or nitrate of baryta, a white precipitate of chlorid of barium or nitrate of baryta may appear, because these salts are far less soluble in free acids than in water."

As it seemed to me possible, however, that the precipitate produced by chlorid of barium solution in nitric acid might contain some *nitrate* I determined to examine it. A quantity of this coarse crystalline precipitate was therefore drained, dried by pressure between folds of paper, and finally heated on the sand-bath until it no longer reddened litmus paper. It then presented the appearance of a fine white powder, which when heated in a glass tube fused easily to a clear colorless liquid without giving off water. At a higher heat the liquid gave off bubbles of red gas. Its solution in water gave a very strong reaction for nitric acid and one much less marked for chlorine. 1·0375 gram gave 0·9233 of BaO, SO^3, which is equivalent to 1·0347 of pure BaO, NO^5. In an attempt at a determination of the chlorine, 0·297 gram of the substance gave one milligram and a half of $AgCl$. We thus come to the rather unexpected result that this precipitate, instead of being chlorid of barium as heretofore supposed, is pure *nitrate of baryta*. In a subsequent experiment, the precipitate formed by an excess of nitric acid in a strong solution of chlorid of barium was washed twice by decantation with pure nitric acid, then dried, first upon a slab of porous earthenware biscuit, and finally upon the sand-bath. It was then chemically pure nitrate of baryta and contained no trace of chlorine. The first liquid poured off from it gave no reaction with dilute sulphuric acid in the cold, but a cloudiness appeared on warming it. It gave however with nitrate of silver a very strong curdy precipitate. It is therefore evident that when strong nitric acid is added to a solution of chlorid of barium in excess in the cold, very nearly the whole of the barium is immediately converted into insoluble nitrate, and chlorohydric acid is set free in the liquid. It is plain, also, that the reason why solid chlorid of barium resists decomposition by nitric acid is that it becomes immediately covered with a coating of nitrate of baryta soluble with difficulty in the acid. In order to ascertain whether the presence of an excess of chlorid of barium modifies the result, a strong solution of the chlorid was added in large excess to nitric acid. The precipitate, collected on a filter, pressed strongly between folds of paper and dried on the sand-bath, contained but a trace of chlorine. The filtrate contained but little nitric acid.

On experimenting with chlorid of strontium similar results were obtained. A stronger solution however, was required, and the precipitate did not appear so soon and was more coarsely crystalline. It contained, after being rinsed with nitric acid, dried on

porous earthenware and then on the sand-bath, but a faint trace of chlorine. The liquid poured off contained but little strontia, giving a precipitate with sulphuric acid only after standing for some time.*

8. *Aluminium.*—Pure chlorid of aluminium left, after one evaporation with acid of 1·29 sp. gr., a nitrate beautifully crystallized in thin plates, which contained no chlorine and deliquesced only in very damp air. These crystals were not further examined.

9. *Glucinum.*—The pure chlorid† was entirely converted into nitrate by one evaporation with acid of 1·29 sp. gr.

10. *Iron.*—Experiments were made upon the green crystals of the anhydrous sublimed sesquichlorid, and upon a solution of the same. Any experiment with the protochlorid is obviously useless. In all cases it was found almost, if not quite, impossible to expel all the chlorine. After frequently repeated evaporations with acid of 1·29 sp. gr., traces of chlorine remained. When the evaporation was conducted on the water-bath a large quantity of a reddish brown substance insoluble in water was formed, and water poured on the residue was exceedingly difficult to filter clear. After filtration it had a brownish red or exactly port-wine color, and gave marked indications of the presence of chlorid, but contained also a large proportion of nitric acid in combination, as was proved by the *indigo test*, after precipitating the oxyd of iron with ammonia. The indigo test cannot be applied in iron solutions without this previous precipitation, both on account of their color, and because of the unexpected discovery, which I shall more fully set forth in another paper, that solutions of the sesqui-salts of iron themselves bleach solution of indigo powerfully when no nitric acid is present.

The port-wine-colored liquid, I may remark, contained undoubtedly one of Ordway's polybasic sesquinitrates of iron.‡ On adding to it a little chlorohydric acid *a precipitate was at first formed*, but on standing for a few minutes the liquid cleared up again, at the same time changing its color to the clear pure brown of sesquichlorid of iron. The portion of the residue insoluble in water having been washed, (in which operation it nearly all ran through the filter,) until the washings no longer gave a chlorine reaction, was examined and found to contain both chlorine and nitric acid.

* The action of nitric acid *in the cold* upon the chlorids will be examined, and the results presented in a subsequent part of this memoir. It opens a new field, probably more or less fertile in *practical* applications, which was entirely unforeseen at the commencement of this investigation.

† Made from pure carbonate obtained from Mr. James R. Brant of New York City.

‡ Am. Jour. Science, [2], ix, 32; Liebig and Kopp's Jahresbericht for 1850, p. 328.

[redacted]

Another experiment was made with the fuming acid of spec. grav. 1·43, upon the sublimed sesquichlorid. It quickly dissolved in the acid to a brown yellow solution, which was evaporated, at first rapidly, but afterwards very carefully at a heat much below 100° C., in order to avoid decomposition of the nitrate formed. The brown gummy translucent residue, having been exposed for some hours to a very gentle heat to drive off all traces of free acid, was deliquescent in moist air, and gave with water a clear dark brown solution leaving little or no insoluble residue. It still contained a trace of chlorine.

The influence of the coöperation with the nitric acid of some other oxydizing agents was tried, but so far without success. Those experimented with were the deutoxyds of lead and manganese and arsenic acid. Chlorine was still present after four evaporations with the acid in conjunction with the deutoxyds.

11. *Manganese.*—Both the dry chlorid of manganese and its solution lost all chlorine by one evaporation with excess of nitric acid.

12. *Cobalt.*—Chlorid of cobalt was also converted entirely into nitrate by one evaporation. In applying the indigo test for nitric acid in cobalt solutions, the colors of which interfere with it, I resorted to the ingenious expedient for the application of Crum's manganese tests to these solutions given by Dr. Gibbs, in his "Contributions to Analytical Chemistry,"* which consists in previously neutralizing the color of the cobalt solution by adding a solution of *chlorid of nickel.*

13. *Nickel.*—Chlorid of nickel behaved with nitric acid precisely like chlorid of cobalt. The green color of nickel solutions interferes still more with the indigo test than the cobalt colors, but the difficulty is readily and effectually overcome by Dr. Gibbs's method, that is, by previously destroying the green color by addition of chlorid of cobalt.

14. *Zinc.*—After *five* repetitions of the treatment with nitric acid of sp. gr. 1·29, the chlorid still retained chlorine. Pure fused chlorid of zinc was then boiled with acid of sp. gr. 1·43. It dissolved gradually, with evolution of brown gas, and gave a colorless solution, which when evaporated at a gentle heat, left a crystalline translucent residue. Every trace of free acid having been expelled, the residue was boiled with water. A white substance remained undissolved in considerable quantity. The solution contained both chlorine and nitric acid in large quantity, and the white substance having been well washed, contained but little chlorine, and was most probably one of the basic nitrates of Grouvelle and Schindler.†

15. *Cadmium.*—The chlorid, like that of zinc, resisted five repetitions of the action of nitric acid of sp. gr. 1·29. Pure crystallized chlorid of cadmium, dried at a gentle heat to expel

* Am. Jour. Science, [2], xiv, 204.

† Gm. Handbuch, iii, 32.

its crystal-water, was boiled with acid of 1·43 sp. gr., and dissolved with difficulty, giving off brown gas. The clear colorless solution was evaporated slowly, raising the heat towards the last until all free acid was expelled. The crystalline residue dissolved completely in water and the solution contained both chlorine and nitric acid.*

16. *Copper.*—Chlorid of copper proved to be difficult of decomposition. After three evaporations with acid of 1·29 sp. gr., water poured on the residue dissolved it but partially, leaving behind a quantity of a bluish green verditer-like substance, probably the tribasic nitrate of Proust, $3CuO, NO^5+HO$.† The filtrate contained but a faint trace of chlorine, and had a dark greenish blue color, which upon the addition of chlorohydric acid changed immediately to a widely distinct *greenish brown* hue.‡ By the indigo test much nitric acid was found in it.§

The verditer-looking substance was boiled with water, and washed until the washings no longer reacted with sulphohydric acid. Dissolved then in nitric acid the solution contained no chlorine, but on solution in chlorohydric acid much nitric acid was found.

Crystals of $CuCl+2HO$ were heated cautiously until converted into the brown anhydrous chlorid, which then slowly dissolved when heated with nitric acid of sp. gr. 1·43, with evolution of brown gas, to a blue liquid. This liquid, evaporated to dryness at a very gentle heat left a blue crystalline residue, which still contained a trace of chlorine and was altogether identical with the one above described.

17. *Chromium.*—The chlorid of this metal yielded very readily. After the first evaporation with nitric acid no chlorine could be detected.

18. *Uranium.*—The residue after the first evaporation of the terchlorid with nitric acid crystallized beautifully in lemon-yellow prisms of the well-known compound of nitric and uranic acids. They contained no trace of chlorine.

19. *Subchlorid of Mercury.*—According to A. Vogel,‖ "calomel dissolves in hot nitric acid with evolution of nitric oxyd as protochlorid and nitrate of the protoxyd,

$$3Hg^2Cl+4NO^5=3HgCl+3(HgO, NO^5)+NO^2."$$

* The paper which covered the dish during the evaporation, although the heat had never approached the boiling point of the liquid, contained much cadmium, and was turned deep yellow by solution of HS; a curious result which requires confirmation.

† Gm. Handbuch, iii, 417.

‡ Gladstone (Liebig and Kopp's Jahresb. 1855, p. 416,) describes the color imparted to copper solutions by excess of HCl as *yellowish green*. To my eyes it appears as above.

§ The application of the indigo test to Cu solutions as also to those of the next two metals, Cr and U, requires certain precautions to be described in a special paper on the subject before alluded to, which is in course of preparation.

‖ Gm. Handbuch, iii, 512.

Some pure calomel, which left no residue when heated on platinum foil, was boiled with nitric acid of sp. gr. 1·29. It slowly dissolved, with evolution of red-brown gas to a colorless solution. This when evaporated left a residue mostly soluble in water, the solution containing both chlorine and nitric acid. When acid of 1·43 sp. gr. was used the solution took place very rapidly. The colorless solution evaporated at a very gentle heat let fall at first acicular crystals (HgCl), and dried up to a crystalline residue, which when treated with hot water dissolved in great part, leaving a small quantity of yellowish residue mingled with some heavy black powder. The solution contained much nitric acid.

20. *Protochlorid of Mercury.*—Experiments were made with corrosive sublimate both in solution and in the solid form. The results with calomel had led me to expect difficulty in decomposing this chlorid, but I was not prepared to find it totally unacted upon. Nitric acid, whether concentrated or dilute, was found to be wholly inert, and after the most prolonged and repeated evaporations, the corrosive sublimate was left behind, in the form of acicular crystals, *entirely unchanged.* When the chlorid was very finely pulverized, boiled for some time and evaporated with acid of 1·43 sp. gr., the result was the same. In no case could nitric acid be found in the residues, except as a minute trace. In this connection the extremely difficult solubility of corrosive sublimate in nitric acid is worthy of mention. According to J. Davy,* it "requires more than 500 parts of hot nitric acid of sp. gr. 1·41 for solution."

21. *Lead.*—Gmelin says, while treating of the purification of nitric acid, that "by means of oxyd of lead nitric acid cannot be freed from chlorine, because chlorid of lead is soluble in it and in the heat decomposable by it."† A solution of chlorid of lead left, after one evaporation with excess of dilute nitric acid, a residue containing no trace of chlorine. A quantity of pure precipitated chlorid was then digested with acid of 1·29 sp. gr. on the sand-bath, and was observed to change rapidly during the operation into a granular crystalline powder. The acid having been renewed several times until this change appeared complete, a little hot water was added, which dissolved the whole mass, and the solution contained nothing but nitrate of lead, without a trace of chlorid. The decomposition was surprisingly easy and complete, considering the insoluble character of the substance.

22. *Silver.*—The action upon chlorid of lead being so powerful, I was by no means led to anticipate the result obtained with chlorid of silver. On the contrary, I certainly expected to ob-

* Gm. Handbuch, iii, 520. † Ibid., i, 804.

tain some indications of decomposition. But on boiling for a long time freshly precipitated chlórid of silver with nitric acid of 1·29 sp. gr., renewing the acid frequently, not a trace of silver could be detected in the filtrate, and on evaporating acid of this strength repeatedly to dryness upon the same mass of the chlorid, the residue yielded to water no silver. A quantity of the chlorid (which had acquired a violet tinge by exposure to light) was then finely pulverized and boiled with acid of 1·43 sp. gr., with the addition of a little chlorohydric acid to provide against the possible presence of metallic silver or the subchlorid, for twelve hours. Under the influence of the acid the violet tinge very quickly disappeared, the mass becoming white. The mixture was then evaporated to perfect dryness upon the sand-bath, and water poured upon the residue. In the solution silver was now easily detected with chlorohydric acid, but on examination for nitric acid, *not a trace* could be found in the liquid. The silver was found to be present in the form of *sulphate*, the sulphuric acid having been derived from a minute trace existing in the nitric acid, which had distilled over with it during its rectification.* It may then be asserted that boiling nitric acid of 1·43 sp. gr. is wholly without action upon chlorid of silver. We have here then a new and striking distinction between the two metals, lead and silver, which in many other respects approach each other in their chemical relations and reactions.

23. *Gold.*—According to Pelletier,† "nitric acid, on account of its easy volatility, has no action upon terchlorid of gold." Pelletier's *fact* I find substantially confirmed by careful experiments, but the explanation which he assigns may reasonably be held in doubt. A solution of pure terchlorid of gold was evaporated at an *extremely* gentle heat (much below 100° C.) and the residue, which was crystallized in beautiful radiating tufts, treated with nitric acid of 1·43 sp. gr., in which it dissolved to a clear yellow liquid. This was evaporated, first on the sand-bath, and when concentrated, at a temperature little above that

* This nitric acid was prepared originally by distilling saltpetre with oil of vitriol, the first portions being rejected as containing chlorine, and was re-distilled carefully, at the lowest possible temperature, until about two-thirds had gone over, under the expectation, which appears to have been fallacious, that the sulphuric acid would remain behind in the retort. No precipitate could be obtained from it directly with nitrate of baryta, and the minute contamination would have entirely escaped discovery, but for the result of the experiment on AgCl. On evaporating a little to dryness, however, after admixture with BaO, NO_5, and redissolving, a distinct cloudiness appeared. Gmelin, in the course of his directions for preparing strong nitric acid (Handbuch, i, 805), recommends that the acid which has been concentrated by distillation with HO, SO_3 should be freed from the latter by re-distillation, "either by itself or over saltpetre." It is evident from the above that distillation by itself will not answer. Nitrate of baryta might be better than saltpetre, and nitrate of silver probably still better, because it would retain both the sulphuric acid and the chlorine.

† Gm. Handbuch, iii, 672.

of the air. The residue, which crystallized just as before, as a radiating fibrous mass, was deliquescent, and gave with water a clear yellow solution, leaving behind a very little metallic gold as a brown powder. This trace of metallic gold was the only evidence of decomposition that could be obtained, as the solution gave only doubtful indications of the presence of nitric acid. In fact, even if the decomposition had been considerable, no distinct evidence of nitric acid in the residue could be expected, for, according to Vauquelin and Pelletier,* solutions of the nitrate of teroxyd of gold leave on evaporation a mixture of oxyd of gold and metallic gold.

24. *Platinum.*—Bichlorid of platinum was as slightly acted upon by nitric acid as the terchlorid of gold. Upon operating precisely as with the gold compound, a residue was obtained which yielded to water unchanged bichlorid of platinum, with no distinct nitric acid. A very slight brown residue however was left undissolved by the water which gave indications of nitric acid, and was probably a basic nitrate; for Berzelius says† that the nitrate of deutoxyd of platinum on evaporation to dryness leaves a residue but partially soluble in water with separation of a basic salt.

25. *Tin.*—According to Gay-Lussac,‡ "bichlorid of tin, when heated with nitric acid, evolves chlorine and nitric oxyd and lets fall stannic acid." I have experimented only with the protochlorid. Pure crystals of this, after evaporation repeatedly with acid of 1·29 sp. gr., appeared to be principally converted into stannic acid. Water poured on the residue after the third evaporation and filtered, contained some chlorine (as bichlorid?) and but a trace of nitric acid.

26. *Arsenic.*—Arsenious acid was dissolved in hot chlorohydric acid, the solution mixed with excess of nitric acid of 1·29 sp. gr., and evaporated to dryness at a gentle heat. The white residue dissolved easily and completely in water, being in fact nothing but pure *arsenic acid*, and the solution contained no trace of either nitric acid or chlorine. It gave the reddish brown precipitate with nitrate of silver which is characteristic of arsenic acid.

27. *Antimony.*—Terchlorid of antimony, according to A. Vogel,§ "evolves with hot nitric acid, chlorine gas, whilst a white powder (antimonic acid) precipitates. The residue left on boiling the terchlorid with nitric acid of 1·29 sp. gr., and evaporating, was treated with dilute sulphuric acid, which partially dissolved it, the solution containing both chlorine and nitric acid in considerable quantities. The undissolved portion, consisting undoubtedly chiefly of antimonic acid, was washed for a long

* Gm. Handbuch, iii, 674.
† Ibid., iii, 738.
‡ Ibid., iii, 83.
§ Ibid., ii, 786.

time, the washings constantly affording a slight chlorine reaction, due to the presence of a difficultly soluble subchlorid or oxychlorid. On dissolving this washed substance in nitric acid, traces only of chlorine appeared in the solution; but on dissolving it in chlorohydric acid, a considerable indication of nitric acid was obtained by the indigo test. It would seem therefore that the above reaction of Vogel is not carried out with precision. It may be useful to call to mind here that according to Berzelius and H. Rose,* both antimonious and antimonic acids are perfectly insoluble in nitric acid.

28. *Bismuth.*—According to Jacquelain,† the oxychlorid of bismuth, $BiCl^3, 2BiO^3$, "dissolves in hot nitric acid, and on evaporation remains behind unchanged." Nitric acid, boiled and evaporated with terchlorid of bismuth, left a residue from which water dissolved little chlorine but abundance of nitric acid, while the insoluble portion dissolved readily in nitric acid, and contained abundance of chlorine.

(To be continued.)

ART. XXXIII.—*The Passage to the North Pole;* by Dr. I. I. HAYES.

MY attention has been directed to an article in the January number of the Journal of Science, upon "The Open North Polar Sea, by R. W. Haskins, A.M." A further discussion of the subject may perhaps not prove uninteresting to the readers of that ably written and comprehensive synopsis of the author's researches among the old records, and I propose to consider the probable value of the evidence which Mr. Haskins has brought forward, of navigators having reached to a high northern latitude, as bearing upon the question of an open Polar Sea and of Arctic navigation, and to show the reasons which exist for the belief in the practicability of reaching the North Pole.

Mr. Haskins has, as he informs us, drawn largely from the material collected by the Hon. Daines Barrington. This gentleman was a lawyer, naturalist and antiquary, of some distinction. He read two papers before the Royal Society upon the subject of arctic navigation, and also collected and prepared a number of papers and letters upon the same topic; all of which were presented to the same Society, and were collectively published by their author in 1776, and again by Col. Beaufoy in 1818. The little volume was entitled, "The practicability of reaching the North Pole asserted;" the object in view being to

* Gm. Handbuch, ii, 791.

† Ibid., ii, 856.

prove, that on different occasions since the efforts of the commercial world had been directed to the Polar seas, the ice had been opened so as to admit the passage of vessels to an extremely high latitude, and that whale ships had repeatedly penetrated to the heart of the Arctic Ocean, far beyond the line of the supposed perpetual Ice Barrier, finding an open sea, navigable "even under the very pole." He communicated either personally or by letter, with every captain, mate or seaman whom he could find that had ever been to the region, and the old salts of Hull, and of Amsterdam, and of Leith, found their stories as highly prized in the halls of the Royal Society, as in the beer saloons where they had heretofore retailed them unmolested. The labors of Mr. Barrington gave him a commanding influence, and he prevailed upon the President of the Society to make representation to Lord Sandwich, then at the head of the Admiralty, which resulted in the fitting out of an expedition for discovery in the northern seas. This expedition commanded by Captain Phipps (Lord Mulgrave) sailed for Spitzbergen May 26th, 1773.

It was broadly asserted by Barrington that there was an open sea at the North Pole, and that although much ice would during some seasons be met between the 70th and 80th parallels of north latitude, yet the open sea had been reached and might be again. Many authorities and evidences were cited to prove his hypothesis and assertions. He found the inhabitants of northern Russia and Siberia to confirm his views, and he was told that water-fowl were seen flying to the northward, evidently in search of warmer latitudes. Those who had been to the region assured him that the north winds were often warm, and that a gale from that direction brought frequently a heavy sea, which, it was assumed, could not be the case if the water were covered by ice; and lastly, he produced a number of instances of positive proof from the personal observations of those with whom he had communicated. In his first two papers it was shown, that four vessels had penetrated to the parallel 81° 30′, seven to 82° and upward, three to 83° and upward, six in company to 86°, three to 88°, two to 89°, and one to 89° 30′, besides many others brought forward subsequently. He even went so far as to assert, that a ship had once gone two degrees beyond the Pole, and exhibited a map published under the auspices of the Royal Academy of Berlin, placing a ship at latitude 90°.

It would be important in the consideration of the question of an open north polar sea to believe these evidences true; but at best, they are of only doubtful value, and more recent writers upon the subject have never attached much importance to them. The late Dr. Scoresby, whose energy and sagacity as a navigator were only exceeded by his truthfulness and impartiality as a

historian, in his valuable work upon "The Arctic Regions" thus speaks of them. "All beyond the 84th parallel are given with very loose authority, such as the vague reports of the Dutch whale-fishers, and in no case from the direct communication of the voyagers themselves. As such there is no reliance whatever to be placed in these very extraordinary reports. Of the remainder, although said to have been given from celestial observation, in reality they are reported from memory. But with regard to those accounts communicated by the voyagers themselves, we find above one-half were from oral testimony, at the distance of eighteen or thirty years from the time." Dr. Kane, after a careful examination of their conflicting statements, was satisfied that they were wholly worthless, as data upon which to found an hypothesis; and in a paper read before the American Geographical and Statistical Society, December, 1852, said, that "after discarding the apocryphal voyages of the early Dutch, whose imperfect nautical observations rendered wholly unreliable their assertions of latitudes, we have the names of but two who may be said to have attained the parallel of 82°, Hendrick Hudson in 1607, and Edward Parry in our own times." Barrow attached to them more importance, and within limits accepted them as worthy of credit. In summing up the probable chances of success attending the effort of Buchan and Franklin in his "Voyages to the Arctic Regions," he asserted his belief "that it was not merely a matter of opinion that several ships had at different times been carried three or four degrees beyond Spitzbergen and the usual limits of the whale fishery."

While these evidences should be accepted with caution they need not be wholly discarded. The authority upon which they are founded is such, that no one who has a care that his theories should have facts to sustain them, can do more than assume their possible truth. The observations were made by wholly irresponsible persons. The reports come from men who it is true had no theories to maintain, and might therefore be in this sense considered disinterested, but on the other hand, having no reputation to gain or loose, and no personal or government dignity or service to sustain, they were without some of the motives to carefulness of statement. The interest attached to the Arctic regions was even greater then than now, and he who went farthest north had an enviable notoriety among his fellows. They were in every case whalers, and were often in the field side by side with government expeditions, all of which failed with the single exception of Parry, to penetrate beyond 82°. Hudson is said to have reached this parallel, but I must express a doubt if he went beyond 81°. Poole reached only to 79° 50′. Fotherby, after repeated efforts, did not get beyond 80°, nor did the indefatigable but unfortunate Barutz or his companion Corneliz

succeed better. The highest latitude of Phipps was 80° 48′, of Tschelschagoff 80° 30′, of Buchan and Franklin 80° 32′, of Clavering 80° 20. They were all arrested by the ice-barrier stretching across from Nova Zembla to Greenland. Parry did not make his greatest northing by water. When arrested off Hakluyt Headland to the northwest of Spitzbergen he abandoned his vessel and boldly struck out with sledge boats over the ice; but reaching to 82° 45′ he found the current carrying him upon his frozen raft to the southward, and unable longer to stem the drift he was compelled to return. Of the recent navigators, the Scoresbys have sailed nearest to the pole, and Prof. Leslie places them above all others of any time, declaring "the statements of the Dutch, and other navigators, who boast of having gone nearer, to be subject to great doubt." In 1806 these gentlemen, the father as captain and the son as mate of a whale ship, reached the parallel of 81° 30′ in the meridian 19° E. longitude, finding the sea open in every direction as far as could be seen from the "crow's nest." It is unfortunate that duty to their employers should have compelled their return to the fishing grounds of Spitzbergen.

The history of early maritime discoveries has always much of the true and of the marvellous so closely associated, that it is not an easy task to separate them, and it is to be regretted that we are not in possession of data which will enable us to determine what is true and what is false of these Arctic records. The proved unreliability of some of them may very naturally make us suspicious of the whole. One of the instances brought forward by Mr. Haskins is that of Davis or Davies, who, it is asserted by Camden, reached to latitude 83°. Now it is well known that the efforts of this bold navigator were confined to the channel which bears his name, and through which he could hardly have passed so far as 83°. It is evident from his descriptions that he did not pass the "middle ice" of Baffins Bay, but we know on the other hand that he discovered and named Sanderson's Hope, lat. 72° 34′. His greatest latitude was about 73°. Captain Larkin of Leith was reported, and for many years was believed, to have reached lat. 80° in Baffins Bay. This would place him at the mouth of Kennedy Channel. It is now known that he did not go beyond 77°. Two other instances are quoted by Mr. Haskins, which, although not impossible, are highly improbable; these are, Capt. Clarke, said to have reached 81° 30′, and Capt. Bateson, 82° 15′, in 1773. Now this was the season during which Phipps made his effort to reach the Pole, and skirting the ice barrier through eighteen degrees of longitude, he at no time, as already stated, penetrated beyond 80° 48′.

Whatever estimate however we may place upon these early records, there can be no doubt but that the Spitzbergen sea is

much more open during some seasons than others, and it is not an unimportant fact in this connection that the whale fishers who have visited those seas during the present century have believed that a passage may be found to the Pole during some seasons; but they have invariably met the ice barrier off Hakluyt Headland; and if the reports of their predecessors be true, we must believe, from the fact that little mention is made of this ice barrier, that the sea was much more open formerly than now; and we must suppose too that the government expeditions were unfortunately sent out in unfavorable seasons. But be this as it may, the Spitzbergen sea is now too closely ice-bound to render the passage to the Pole probable during the great majority of seasons, or safe during any, and I am convinced that the plan adopted by Sir Edward Parry is the only one practicable for accomplishing that desirable result, for which men have been striving through centuries. This daring feat, which Dr. Kane justly declares "unequalled in the history of personal enterprise," was made without previous experience, and the obstacles to the success of the enterprise were numerous. Many of these obstacles have been removed, for they were embraced in the equipment and season chosen for the effort. The experience gained by Parry, and during the search for the unfortunate crews of the Erebus and Terror, will I think, if properly used, insure success to the next polar enterprise, by whomsoever it may be conducted. Parry found his boats needlessly heavy, his crews were unnecessarily large, his provisions were disproportionately weighty and uselessly bulky, and he started too late in the season. He did not leave the Seven Islands of Spitzbergen until the 22d day of June, the middle of the summer solstitial period; besides, he travelled over a boundless sea, and when the body of the ice commenced to drift southward with the current, he was carried with it to his starting point. This was his greatest drawback, and to secure success to a similar attempt a route should be selected free from this chief objection. Such we have in Smith's Strait and Kennedy Channel—the seat of Dr. Kane's operations. This route affords every facility for boat and sledge travel. A harbor could be secured, I have every reason to believe from personal observation and surveys, as high up in the channel at least as the 79th parallel if the western shore be selected, and if the season should prove as open as that of 1853 the leads would admit the passage of a vessel to the little bay in the coast between Capes Leidy and Frazier, latitude 79° 45′—distant from the Pole only 615 geographical miles. This locality was visited by me in company with Wm. Godfrey in the spring of 1854, and if reached would afford a secure harbor. The report of this journey, published in the appendix to Dr. Kane's "Arctic Explorations," will give

more in detail than my present limits will allow the facts bearing upon the question, and to it, and the chart exhibiting the discoveries of the cruise accompanying the same volumes, I will invite the attention of readers who may wish to pursue the subject further. By an examination of the coast-lines upon that chart and with the knowledge that the current sets south, the reader will readily perceive that the western shore presents greater facilities for reaching a high north latitude by means of a ship than the eastern, which receives directly upon it the drift from Kennedy Channel, the pressure of which drove Dr. Kane into winter quarters at Rensselaer Bay, in latitude 78° 37′.

A harbor being secured, the winter should be passed in preparation, and upon the opening of spring, or immediately upon the return of daylight, cargoes of provisions should be carried forward by means of dogs and sledges, and depots secure from the bears established at different points, extending as far north upon Grinnell Land as possible. According to the observations of one of Dr. Kane's exploring parties (Wm. Morton and Hans Christian) this land extends, by a rude estimate, at least to latitude 82° 30′. A light boat should follow the provision stores, and properly mounted upon runners it could be readily transported by its crew. In the mean time the water would advance from the north, eating away the polar margin of the ice belt; and I conjecture that by the middle of May it will be found between the 81st and 82d parallel, or about 500 miles from the Pole. Morton reports the water one month later in the season at latitude 80° 20′. To make this distance in boats is easily practicable.

The advantages possessed by this route over that of Parry will be readily seen. We have land as a basis of operations, extending at least to 82° 30′, serving not only as a sure foundation for depot stations, but checking the equatorial drift of the early break up of the ice,—thus at once obviating Parry's chief difficulty.

That open water will be found within and to the northward of Kennedy channel every summer, I have no doubt; and as the season advances, the open water will continue to advance to the southward, its extreme limit varying with the mildness or severity of the season: for I take it to be now a well established fact that the Arctic Ocean has within it an open sea in summer; the only doubt resting with the cold months of mid-winter, and even during these the indications are in favor of an affirmative hypothesis. But this last need not be considered in any scheme for the navigation of the Polar Sea, for that is dependent only upon open water during the months of May, June, July, August and September. On the 21st of June, Morton met the open water so low as latitude 80° 20′, and this was a season not

unusually mild; on the contrary it was much less so than the preceding summer. I think we may be safe in assuming that the solid field ice will in no case be found to continue farther to the northward than the parallel of 81° or 82°, within which limits successful operations can be performed. At this point the surface-water as observed by the party above referred to was found to be at 36° F., two degrees above the temperature of the air. The value of this observation can scarcely be over-estimated, and coming as the water did down from the north, it would certainly seem to indicate the existence of an area great or small within the Arctic Ocean, the influences operating upon which tend continually to keep the temperature of the sea elevated above the freezing point. The region is shrouded in mystery, and we know not what these influences may be, whether from oceanic currents or from whatever cause. But there is no need of speculation and I will leave the higher task of philosophic reasoning to more competent persons. The facts which point to the operation of such influences as those above mentioned are conclusive. The temperature of the air and water, the distribution of plants, the migrations of animals, show the existence of those influences in the neighborhood of the Pole. Analogies of physical geography confirm the hypothesis that they are sufficient to produce continued open water, as positive observation by the Russians above Siberia, by the English and Dutch to the northward of Spitzbergen, and by Dr. Kane's parties within Kennedy Channel, prove that it exists throughout the warmer half of the year.

The geographic pole is no longer to be considered as the point of maximum cold. This great centre of revolution is not the center of most intense frigorific power, as is pretty clearly shown by the isothermal curves projected by Humboldt and continued by Berghaus, Dové, Maury, Schott and others. These curves point to the existence of two centres of cold within the arctic circle. The position of these centres has not been accurately determined, and it matters not for our present purpose whether or not they coincide, as was conjectured by Brewster, and as the subsequent investigations of Kupffer, Duperrey, Prof. Norton and others would seem to indicate, with the poles of maximum magnetic intensity. That they exist there can be no doubt, and their existence is a most natural inference apart from direct observation. If the reader will take the trouble to refer to his globe, or to a chart of the Arctic Ocean, he will see that there are two points about which there would be a natural accumulation of ice by the operation of the centrifugal force alone. These points are about the Parry and New Siberian groups of Islands. Around centres not far removed from the crossing of the 78th parallel of latitude and the 95th meridian of western longitude,

and the 78th parallel of latitude and the 130th meridian of eastern longitude, are deflected the isothermal curves of the northern hemisphere.

The same causes which would tend to the accumulation of ice about these centres would operate to clear the region immediately about the Pole, and just in proportion as this result is effected will the thermal influences of the water be felt upon the air; which influence will be magnified by the forces constantly operating, as already shown, to keep the temperature of the waters about the Pole elevated considerably above the freezing point, and I will here again direct the reader's attention to the fact that the water coming down from the north through Kennedy Channel, as observed by Morton, was 36°.

That these influences are operating we know from the isothermal lines, as above mentioned, and we have equally irresistable proof in the migrations of the birds. Throughout the entire circuit of the Arctic Ocean it has been observed, that water-fowl fly to the northward in the spring. The fact has been noted at Koola, at Nishne Kolyrusk, at the mouth of the Mackenzie in Baffin's Bay; and upon the open waters bordering the extreme Polar limit of known land, they were seen by Morton in flocks of hundreds and thousands. At Rensselaer harbor I have seen immense flocks of the same birds passing northward in the spring and south in the autumn, and I have no doubt but that the extreme north lands of our planet are teeming with bird-life, and if so, I need hardly say that the sea is open at least during the period of their stay, and affords not only favorable breeding places for them, but is favorable also for the development of marine life; for these birds, represented in the three great families, *Brachypteræ*, *Longipennes* and *Lamellirostres* by the Auk and Loon, the Tern and Kittiwake, the Brent goose and Eider duck, draw their subsistence entirely from the water, feeding for the most part upon different species of *Crustacea* which are not richly multiplied either in species or individuals in waters of extremely low temperature.

There are many other facts which might be cited to prove the more than probable existence of a perpetual open sea within the Arctic Ocean, but to do this does not fall within the sphere of my original purpose. I wish merely to show that there must be open sea during the summer, and that it can be navigated in boats during that period. Those who read this will doubtless have already read an able paper upon the same general subject in the number of this Journal for September, 1857.

The chief difficulty in the way of navigating this northern water rests with the transportation of boats over the ice belt to it, from the winter harbor of the vessel carrying the expedition. But the experience of the past has converted arctic travel almost

to a science, and in this transportation the Esquimaux dog will be found of most essential service. Indeed I am convinced that the services of this animal have been too lightly estimated by the English explorers, while the difficulties of keeping and using them have on the other hand been over-estimated. By depending upon them for all purposes of draught the cost of an expedition could be greatly reduced, and its size diminished more than one half. I think a vessel of one hundred tons, manned by twelve men and carrying from the Greenland colonies two good teams of Esquimaux dogs, (fourteen in number,) would be as effective for field operations when once in winter harbor, as three times the number of men with a vessel twice the size, and much more satisfactory and reliable. Indeed for draught and transportation over the icy deserts of the Arctic Seas there can be no substitute for the dog. A man will carry upon a sledge an average weight of about 112 pounds 16 miles per day, a dog from 60 to 80 pounds from 30 to 40 miles per day. The proportionate advantage in dead weight and distance is in favor of the dog, while in every other respect he is to be preferred, since he will travel with a cargo where men cannot, as proved by the experience of Dr. Kane's parties. He is far more enduring, consumes less food in proportion to the weight he will carry, and if dispatch be required it can always be had, for with a light load one hundred miles may be made in a single march. I have frequently made seventy and eighty, and on one occasion drove a team of seven with two persons upon the sledge one hundred and twenty miles in forty consecutive hours, the animals during the time being almost wholly without food.

Could a winter harbor be secured near the mouth of Kennedy Channel, as I have already stated to be in all probability practicable, two teams of dogs would, if the ice did not prove completely impassable, carry, between the opening of spring and the end of April, provisions—pemmican and bread—to the amount of 1400 pounds, to the northern border of the ice; and by the first of June, a full equipment, including boats and provisions for four months, could with the aid of the same dogs be at the same point ready for embarking. It is unnecessary to enter into further details. The weight to be carried can be computed almost to an ounce; the plan has borne the test of experience, and the ground is partially known.

ART. XXXIV.—*A Chemical Examination of the Commercial Varieties of Brown Sugar;* by JOHN H. ALEXANDER and CAMPBELL MORFIT.

THE impurities of crude sugar are incidental to the cane juice and the process by which it is manufactured. They consist of water, insoluble or suspended matters, soluble organic matters and uncrystallizable sugar. The latter is not only deficient in sweetening power, but conspires, with the water, organic matters, and chlorids of sodium and magnesium of the ash, to decompose the cane sugar or valuable portion and thus depreciate the real value of the commercial sugar. Care was observed to secure fair average samples for the analyses, by having them selected through the agency of intelligent sugar brokers* of long experience. There was no free acid present in any one of them, as we determined by actual tests.

It having been found by preliminary qualitative examination, that the same components were more or less common to all the samples, we arranged our plan of analysis so that it should, in its progress, detect and estimate the smallest quantity of either and all of them.

1. *Water.*—The moist condition of brown sugar is accidental, since it does not contain any water of crystallization. Its tendency to form hygroscopic compounds with the chlorids of sodium and magnesium gives, to these salts when present, the power of affecting, materially, the dryness of the sugar.

The amount of moisture was determined by weighing twenty-five grains of the sugar upon a counterpoised watch-glass and drying it in vacuo, over sulphuric acid and chlorid of calcium, until it ceased to lose weight. The difference between the final and original weights expressed the amount of loss which, being the contained water, was then calculated to per cent.

2. *Insoluble matter.*—The totality of insoluble matter consisting of vegetal remains, sand, dirt, &c., was estimated by dissolving one hundred grains of the sugar in cold distilled water, filtering upon a counterpoised filter, washing repeatedly with cold water, then drying the filter in vacuo and weighing. The weight represented the total amount of insoluble matter.

To separate the organic from the inorganic portion of this matter, the filter was burned to ash in a platinum crucible. The weight of the ash was taken as the per cent of *inorganic* matter; and that which it had lost by ignition, as the *organic* portion.

3. *Albumen.*—The filtrate from the above was next concentrated by careful evaporation upon a sand bath so as to coagulate

* Field and Keemlè, Philadelphia.

the albumen, which was then separated upon a counterpoised filter. The filter having been thoroughly washed with cold water, was afterwards dried in vacuo and weighed to obtain the per cent of albumen.

4. *Casein.*—A few drops of acetic acid were added to the remaining filtrate while hot, but without obtaining any perceptible reaction. Such would not have been the case had casein been present, for though under the circumstances above noted it will not coagulate like the albumen by heat alone, yet it readily separates upon the addition of an acid.

5. *Gum.*—After this treatment, the filtrate was evaporated nearly to syrup-consistence, and the gum precipitated from it by pouring in absolute alcohol. A counterpoised filter was used for the separation of the gum from the liquor, and after having been thoroughly washed with slightly diluted alcohol to remove all traces of sugar, that may have gone down with the gum, it was then dried in vacuo and weighed.

6. *Extractive.*—The coloring and undefined organic matters of the sugar, included under the term extractive matter, were estimated by treating the filtrate from the gum with a clear solution of sub-acetate of lead in bare excess and immediately filtering upon a counterpoised filter, washing thoroughly with hot water, drying in vacuo and weighing. As the extractive matter was alone carried down by the lead, it became necessary merely to ignite the precipitate and note the loss of weight in order to obtain the per cent of extractive.

7. *Ash.*—The mineral constituents of the sugar were estimated by incinerating carefully one hundred grains in a platinum crucible so as to avoid vitrification of the ash. The latter was then weighed to ascertain its per cent; and subsequently put through a qualitative analysis for the purpose of determining its composition.

8. *Sugar.*—New quantities of the sugar were weighed for the estimation of the *cane* and *uncrystallizable* sugars, and the proportion of each was ascertained, directly, by very careful manipulation and the processes of the books. It is proper to remark, however that we have included, under uncrystallizable or molasses sugar, all the kinds present other than cane sugar, such as chylariose and saccharo-glucose, both of which may owe their existence to a partial transmutation of the cane or crystallizable sugar portion.

The following table embraces all the varieties of brown sugar which were accessible at the time of analysis, but it is still wanting of several kinds, including the Sorghum sugar. Reliable average samples of these latter are now being procured, and a supplementary table of their composition will be given as soon as the analyses of them are completed.

Table of the Composition of average Samples of the Commercial varieties of Brown Sugar.

NUMBER.	1.	2.	3.	4.	5.	6.	7.
Name and source of Specimen.	Cuba, prime.	Cuba, fair.	Cuba, common.	Havana, prime.	Havana, fair	Havana, common.	N. Orleans, prime.
Cane Sugar,	96·55	92·69	97·32	97·32	96·40	92·69	94·24
Uncrystallizable Sugar,	0·49	2·95	·38	·40	·65	1·66	·57
Water,	1·70	2·70	·40	·20	1·20	1·00	1·60
Gum,	·19	·32	·40	·15	·51	·32	·21
Albumen,	·20	·18	·14	·14	·22	·96	·26
Extractive,	·42	·94	·30	·87	·87	2·90	1·91
Ash,*	·68	·57	·50	·50	·75	1·20	·78
Insol. matter: Suspended organic matter,	·26	·29	·10	·40	·20	—	·02
Insol. matter: " inorganic "	·22	·18	·09	·25	·20	·22	·14
Total,	100·71	100·82	99·63	100·23	101·00	100·95	99·73

NUMBER.	8.	9.	10.	11.	12.	13.	14.	15.
Name and source of specimen.	N. Orleans, fair.	N. Orleans, common.	Pernambuco, white.	Pernamb'co, brown.	Porto Rico, prime.	Porto Rico, fair.	Porto Rico, common.	Trinidad, Cuba, common.
Cane Sugar,	94·23	93·46	98·25	93·31	97·32	93·61	93·46	91·61
Uncrystallizable Sugar,	1·20	1·52	·23	·54	·12	·56	·94	2·35
Water,	1·30	2·20	·60	·30	·80	3·10	2·70	2·20
Gum,	·14	·04	·23	·81	·16	·24	·56	·32
Albumen,	·16	·41	·14	·76	·52	·50	·52	·58
Extractive,	1·60	2·28	·47	2·46	·49	1·90	1·96	3·86
Ash,*	·64	1·00	·24	1·24	·34	·40	1·15	·38
Insol. matter: Susp'd org'ic matt'r,	·05	·22	—	·24	·03	·22	·30	·39
Insol. matter: " inorg'ic mat'r,	·12	·16	·15	·92	·10	·12	·18	·09
Total,	99·44	101·2[illegible]	100·31	100·58	99·89	100·65	101·77	101·78

* Composition of the ash.

No. 1. Sulphuric, nitric, phosphoric, carbonic and silicic acids; chlorine; potassa, soda, lime, magnesia, alumina.

No. 2. Phosphoric, carbonic and silicic acids; chlorine; potassa, soda, lime, magnesia and alumina.

No 3. Sulphuric, phosphoric, carbonic and silicic acids; chlorine; potassa, lime, magnesia and alumina.

No. 4. Phosphoric, nitric, carbonic and silicic acids; chlorine; potassa, soda, lime, magnesia, alumina.

No. 5. Phosphoric, carbonic and silicic acids; chlorine; potassa, lime, magnesia, alumina, iron.

No. 6. Phosphoric, carbonic and silicic acids; chlorine; potassa, lime, magnesia, iron and alumina.

No. 7. Phosphoric, carbonic and silicic acids; chlorine; potassa, soda, lime, magnesia, iron and alumina.

No. 8. Phosphoric, carbonic and silicic acids; chlorine; potassa, soda, lime, magnesia, iron and alumina.

No. 9. Phosphoric, carbonic and silicic acids; chlorine; potassa, lime, magnesia, iron and alumina.

No. 10. Nitric, phosphoric and silicic acids; chlorine; soda, lime, magnesia, iron and alumina.

No. 11. Sulphuric, nitric, phosphoric, carbonic and silicic acids; chlorine; potassa, lime, magnesia, iron and alumina.

No. 12. Phosphoric, nitric and silicic acids; soda, lime, magnesia, iron and alumina.

No. 13. Phosphoric, nitric, carbonic and silicic acids; chlorine; potassa, lime, magnesia, iron and alumina.

No. 14. Phosphoric, carbonic and silicic acids; chlorine; soda, lime, magnesia, iron and alumina.

No. 15. Phosphoric, carbonic and silicic acids; chlorine; potassa, soda, lime, magnesia, iron and alumina.

New York, 1858.

Art. XXXV.—*Fifth Supplement to Dana's Mineralogy;* by the Author.

List of Works, etc.

Geological Report of Kentucky. Vols. II and III. Louisville, Ky. Besides the Geological Reports, the volumes contain a Chemical Report by Robert Peter, comprising numerous analyses of coal, limestone, iron ores, soils and some rocks.

W. E. Logan: Geological Survey of Canada: Report of Progress for the years 1853-56. Printed by order of the Legislative Assembly. 494 pp. 8vo, with a volume of maps. Toronto, 1847. Contains, besides the Geological Report, an important chemical Report on minerals and rocks by T. S. Hunt.

Robert Phillips Greg, F.G.S., and William G. Lettsom: Manual of the Mineralogy of Great Britain and Ireland. 8vo, with numerous wood-cuts. London, 1858. John Van Voorst, 1 Paternoster Row.

N. von Kokscharow: Materialen zur Mineralogie Russlands.—The conclusion of volume II. (Liefrung 22-27) with the plates 39 to 43, published at St. Petersburg in 1857. These sheets are mainly occupied with the species Phenacite, and splendid figures of its crystals are given on the plates, representing 23 distinct forms.

H. Coquand: Traité des Roches, considerés au point de vue de leur Origine, de leur Composition, de leur Gisement et de leurs Applications à la Géologie et à l'Industrie, suivi de la description des Minerais qui fournissent les Métaux utiles. 424 pp. 8vo. Paris and Besançon, 1857.

Dr. Ferdinand Senft, of Eisenach: Classification und Beschreibung der Felsarten. 442 pp. 8vo, with 12 tables. Breslau, 1857. "Eine gekrönte Preisschrift."

Bernhard Cotta, Prof. at Freiberg: Die Gesteinlehre. 256 pp. 8vo. Freiberg, 1855.

Prof. Dr. Aug. Em. Reuss: Fragmente zur Entwickelungsgechichte der Mineralien. 84 pp. 8vo. Vienna. (From the October number of the Sitz. Wien, for 1856, vol. xxii, p. 129.)

Kopp: Review of Mineralogical Science for the year 1856—in Liebig and Kopp's Jahresbericht for 1857.

J. Roth: Der Vesuv und die Umgebung von Neapel. 540 pp. 8vo, with 12 plates and several wood-cuts. Berlin, 1857. W. Hentz.—An important work, mineralogical as well as geological, and historical as well as descriptive.

Josef Florian Vogl of Joachimsthal: Gangverhältnisse und Mineralreichthum Joachimsthals, 200 pp., 8vo, with a geognostic chart. Teplitz, 1857.

J. Grossmann: Führer in der geometrischen Analyse der Krystallographie.—An introduction to Naumann's system of Crystallography. 138 pp. 8vo, with 29 woodcuts and 1 lithographic plate. Liepzig, 1857.

On the minerals in the Auriferous and Platiniferous Sands of Antioquia, by MM. Damour and Descloizeaux (Ann. Ch. Ph., [3], li, 445, Dec. 1857). The sand of Rio Chico contains, garnet, red zircon, ilmenite, rutile, brownish mica, kyanite, columbite (baierine), monazite and molybdate of lead.

P. Casamajor: A method of measuring the angles of crystals by refraction without the use of a Goniometer.—Am. J. Sci., xxiv, 251.

On the Axial relations of Monoclinic forms (mathematical), by Leander Ditscheiner.—Pogg. Ann., c, 516.

A. Descloizeaux: De l'emploi des propriétés optiques biréfringentes en Minéralogie. 84 pp. 8vo. Paris, 1857. (From the Annales des Mines, 5th ser. vol. xi, p. 261.)

This extended memoir contains the results of many new measurements of the index of refraction and angles between the axes of polarization in crystals, by

izeaux, besides others by earlier investigators, together with some important ions based thereupon respecting certain mineral species. We here tabulate ncipal results as far as this can be conveniently done, mentioning other facts l under the names of the species.

ie table of Uniaxial species, the columns are (1) the Index of refraction for dinary ray; (2) the same for the extraordinary ray; (3) the mean index of ion. *Br.* stands for Brewster; *Sen.* for Senarmont; *Haid.* for Haidinger; r Herschel; *Heus.* for Heusser; *M.* for Miller; *Rud.* for Rudberg; *Dx.* for izeaux. Under the Biaxial species, the columns are; (1) the angle of the iental prism $I:I$; (2) the direction of the plane in which the optical e; (3) the position of the *bisectrix*, or the line which bisects the angle n the two axes within the crystal, which is almost uniformly constant the angle may widely vary; (4) 2V, the real interior angle between the axes; (5) 2E, the apparent angle in the air. α, β, γ, are the three indexes action, the *maximum*, *mean* and *minimum*, as afforded by three prisms,—ism giving the *mean* index having its edges perpendicular to the plane of tical axes; those giving the *maximum* and *minimum*, parallel respectively bisectrices of the *acute* and *obtuse* angles between those axes. The three its of elasticity are consequently $a=\frac{1}{\gamma}$, $b=\frac{1}{\beta}$, $c=\frac{1}{\alpha}$. Descloizeaux states e interior semi-angle of the optical axes about the axis of maximum elasti- obtained by means of the formula $\tan\lambda=\frac{\gamma}{\alpha}\sqrt{\frac{\alpha^2-\beta^2}{\beta^2-\gamma^2}}$, he has compared with hich is deduced from the mean index and the apparent angle measured by of a Wollaston goniometer, using a tourmaline as an analyzer and the hori- mirror of the goniometer as a polarizer. He used in his investigations the st part of the yellow ray.

ng the uniaxial species, all the rhombohedral *carbonates* (excepting parisite) *ative;* all the phosphates and arsenates are *negative;* all the silicates of the mily are *negative.* Levyne and phacolite are *negative*, but chabazite is *posi-* here is a similar relation between different varieties of apophyllite; between t pennines; between eudialyte and eukolite. Willemite (silicate of zinc) is *e;* water and hydrate of magnesia are *positive;* oxyds of tin and zinc are *e;* but rutile is *positive* and anatase *negative;* finally, 71 species are *negative,* *positive.*

ng the biaxial: the carbonates of lime, baryta, strontia, lead, are *negative;* e is *negative* but staurotide *positive;* the most of the zeolites are *positive*, but te and stilbite are exceptions; sulphate of baryta, strontia, lead, lime, anhy- r hydrous are *positive;* talc and the micas are *negative;* clinochlore and ripid- general are *positive;* of the feldspars, orthoclase is *negative*, the others, viz. labradorite, anorthite and oligoclase are *positive.* Orthoclase and the micas uch in optical angle in the same specimen. In all, 70 species are *positive,* *negative.*

I. UNIAXIAL CRYSTALS.

1. *Positive—the vertical axis the axis of least elasticity.*

	1. Ord.	2. Extraord.	3. Mean Index.
rtz, - - - -	1·54418	1·55328 (ray D)	
ethyst, - - -			1·562
nacite, - - -	1·652	1·672 (red ray) *S.*	
otase, - - -	1·667	1·723	
on, - - - -	1·961	2·015, *Br.*	
red, Ceylon, -	1·92	1·97, *Sen.*	
phyllite (leucocyclite),			1·5431, *Her.*
site, - - -	1·569	1·670 (red ray) *Sen.*	
- - - -			1·3095 (yellow ray), *Bravais.*
enockite, - - -	2·688	near ord., *M.*	
h. potash, - -	1·493	1·501, *Sen.*	
mel, - - -	1·96	2·60 (red ray), *Sen.*	

The following also are *positive*. (1) Dimetric: Sarcolite, Apophyllite (of Utö, Fassa, Finland, Andreasberg, Lake Superior, Poonah, Vicentine, Bohemia, Iceland, Faroe, Isle of Skye,) Oxhaverite, Phosgenite, Cassiterite, Rutile, Scheelite (with one of the rays 1·525). (2) Hexagonal: Eudialyte, Catapleiite, Willemite, Chabazite of Andreasberg, Pennine, Leuchtenbergite (hexag.?), White Chlorite of Mauleon, Iodid of Silver, Red Zinc Ore, Brucite, Cinnabar (by recent determination).

2. *Negative—the vertical axis the axis of greatest elasticity.*

	1. Ord.	2. Extraord.	3. Mean
Tourmaline—white,	1·6366	1·6193 (line D.)	
" "	1·64793	1·62617 (gr'n r.) *Heus.*	
" green,	1·6408	1·6208 (red r.) *Sen.*	
" bluish,	1·6415	1·6230 (red r.) *Sen.*	
" blue,	1·6435	1·6222 (red r.) *Sen.*	
" red (rubellite),			1·768, *Her.* 1·779, *Br.*
Beryl—fine green Emerald,	1·5841	1·5780 (green r.) *Dx.*	
" less fine " "	1·5796	1·5738, *Dx.*	
" colorless and rose, Elba,	1·577	1·572 (green r.) *Dx.*	
" aquamarine,	1·57518	1·57068 (gr'n r.) *Heus.*	
" yellowish green, Siberia,	1·582	1·576, *Dx.*	
Nepheline,	1·539 to 42	1·534 to 37, *Dx.*	
Idocrase,	1·719 to 22	1·717 to 20, *Dx.*	
Meionite,	1·594–7	1·558–61, *Dx.*	
Pennine; most sp. from Zermatt and Binnen, and some from Ala,	1·576	1·575, *Haid.*	
Mellite,	1·541–50	1·518–25, *Dx.*	
Calcite,	1·65850	1·48635 (ray D)	
Nitrate of Soda,	1·586	1·336, *Dx.*	
Red Silver,			2·564, *Br.*
Apatite,	1·64607	1·64172, (ray D) *Heus.*	
Corundum, blue and red sapphire,	1·769	7·652, *Miller.*	
Anatase,	2·554	2·493, *Miller.*	

The above are hexagonal, excepting Idocrase, Meionite, Mellite, and Anatase. The following species also are negative. (1.) Dimetric: Gehlenite, Dipyre, Mellilite, Edingtonite, Apophyllite of Cziclowa in the Bannat, Nickel Vitriol, Matlockite, Chalcolite, Wulfenite, Chiolite. (2.) Hexagonal: Eukolite, Levyne and Phacolite (differing from other Chabazite, which is positive), Pyrosmalite, Biotite (of Somma, Norway, Greenland, United States, Siberia, etc.), Brandisite, Dolomite, Ankerite, Magnesite, Breunnerite, Smithsonite, Susannite, Alunite, Chlorid of lime, Protochlorid of iron, Pyromorphite, Mimetene, Erinite, Hedyphane. (3.) Uncertain form: Melinophane, Clintonite, Xanthophyllite.

II. BIAXIAL CRYSTALS.

1. *Positive—the mean line coinciding with the axis of least elasticity.*

A. *Crystallization Trimetric.*

Beyond—*O* is the basal plane; *i-ī* is a vertical plane in the direction of the longer diagonal (macrodiagonal); *i-ĭ*, one in the direction of the brachydiagonal or shorter; under Bisectrix, par. *I* : *I*, means parallel to the edge between *I* and *I*; and norm. *i-ĭ* means normal to the plane *i-ĭ*; and so on; ∴, signifies calculated from the Indexes.

Under the monoclinic system—*i-ì* is a vertical plane in the direction of the clinodiagonal; *i-i* one in the direction of the orthodiagonal, and N. for normal; 40° 32′ to N. *i-i*, means, inclined 40° 32′ to a normal to the plane *i-i*. The interjection mark after 2V or 2E indicates that the calculated angle agrees very nearly with observation.

	I : I.	Plane of axes.	Bisectrix.	2V.	2E.
Staurotide, - - -	129° 40′	i-ī	norm. O	85°, *Br.*	
Andalusite, green, Brazil,	90° 44′	i-ī	norm. i-ī	87° 34′	
Natrolite, Brevicite, - - -	91°	i-ī	par. I : I		90°±
Prehnite, - - -	99° 56′	i-ī	norm. O		119°±
Comptonite, - - -	90° 40′	O	par. mac.	56° 6′, *Br.*	
Thomsonite, Dumbarton,	ib.	ib.	ib.		79°±, *Dx.*
Harmotome, - -	110° 26′	i-ī	norm. O		90°±, *Dx.*
Calamine, - - -	104° 12′	i-ī	ib.		80°±, *Dx.*
Chrysolite, - - -	119° 12′	i-ī	ib.	·: 87° 46′!	
Sulphur, - - -	101° 58′	i-ī	ib.	70°–75°	
Barytes, - - -	101° 40′	i-ī	par. brach.	·: 35° 4′ obs. 36° 48′	·: 59° 6′ obs. 60–61
Celestine, - - -	104° 2′	i-ī	par. brach.	50°, *Br.*	91°, *Dx.*
Anglesite, - - -	108° 38′	i-ī		90°±	
Anhydrite, - - -	96° 36′	O	par. brach.	·: 40° 34′ obs. 43° 32′	·: 66° 14′ obs. 71° 31′, *M.*
Thenardite, - - -	129° 21′	i-ī	par. I : I	90°± !	
Topaz, white, Brazil, -	124° 22′	i-ī	norm. O		100° 4′
" Schneckenstein, -					114° 12′
" yellow, Brazil, -				49° 50′ *Br.*	
" colorless, Brazil,				·: 65° 14′	obs. 120° 50′± ·: 121° 1′
Chrysoberyl, - -	119° 46′	i-ī	par. brach.	·: 45° 20′	·: 84° 43′ obs. 85°, *Dx.*
Scorodite, - - -	98° 1′	i-ī	par. I : I		90°±, *Dx.*
Struvite, - - -	122° 50′	i-ī	norm. i-ī		59° 30′

INDEX OF REFRACTION.—*Staurotide*, β 1·7526 (red ray) M.—*Andalusite*, β 1·624 (red r.) M.; α 1·643, β 1·637, Dx.—*Natrolite*, α 1·522, Br., γ 1·516, Br.—*Comptonite*, one Index, 1·553, Br.—*Chrysolite*, α 1·697, β 1·678, γ 1·661.—*Sulphur*, one Index, 2–2 24.—*Barytes*, α 1·64797, β 1·63745, γ 1·63630.—*Celestine*, one Index, 1·644, Br.—*Anglesite*, one Index, 1·925, Br.—*Anhydrite*, α 1 614, β 1·576, γ 1 571, M.—*Topaz*, white, Brazil. α 1·62408, β 1·61668, γ 1·61452 (ray E), Rud.; Schneckenstein, α 1·62898, β 1·61965, γ 1·6180 (green ray) Heus.; yellow, α 1 6401, γ 1·6325, Br.; colorless, Brazil, α 1·6240, β 1·6174, γ 1 6150 (green r.) Dx.: α 1·6224, β 1 6150, γ 1·6120 (yellow r.) Dx.—*Chrysoberyl*, α 1·7565, β 1·7484, γ 1·7470.—*Struvite*, one Index, 1·52.

B. *Crystallization Monoclinic.*

	I : I.	Plane of axes.	Bisectrix.	2V.	2E.	
Euclase, - -	144° 40′	i-i	40° 52′ to *N.* to i-i	·: 49° 37′	·: 87° 59′!	α 1·6710 β 1·6553 γ 1·6520, *Dx.*
Epidote, - -	116° 53′	i-i	norm. ½-i	87° 5′, *M.*		β 1·7±
Clinochlore, Pa. -		i-i	15° 16′ to *N.* to O		86°±	
" Ural, -	125° 37′	i-i	slight inclin.		50°±, *Dx*	
" Pfunders,	ib.	i-i	ib.		50 ±, *Dx.*	
" Zillerth. & Ala	ib.	i-i			43°±, *Dx.*	
" Tabergite,		i-i	ib.		30°±, *Dx.*	
Ripidolite, - -		i-i			20°—, *Dx*	
Kæmmererite, -					20°—, *Dx.*	
Heulandite, -	136° 4′	O nearly, perp. to i-i	par. orthod.	41° 42′ *Br.*		
Brewsterite, -	136°	53° 40′ to O perp. to i-i	ib.		85°±, *Dx.*	
Pyroxene (diopside),	87° 6′	i-i	22° 54′ to *N.* to O.	58° 57′	·: 111° 28′! *M.*	β 1·680, *M.*
Sphene, - -	113° 20′	i-i	norm. 1-i	30° 22′		β 1·631. *M.*

Gypsum.—$I:I=111° 22'$: plane of axes *i-ī* at ordinary temperature; at 9°·4 C., the bisectrix inclined 37° 28′ to normal to *i-ī*; at 9° C., 2V=61° 24′; at 80° C. the two axes unite and are confounded with their bisectrix; above 80°, they separate again, but in a plane normal to *i-ī*. $\alpha=1·52975$, $\beta=1·52267$, $\gamma=1·52056$, for the yellow rays furnished by an alcohol lamp treated with salt, at the temperature of 19° C., according to Angström; whence 2V=57° 31′.

C. *Crystallization Triclinic.*

Albite.—Plane of axes apparently normal to the edge $I:I'$, and inclined about 11° to a normal to *i-ĭ*; bisectrix inclined 10°–12° to a normal to *i-ĭ*, and 83° 35′ to 81° 35′ to a normal to *O*. Angle between the axes as great as in orthoclase if not greater.

Labradorite.—Nearly as in Albite. Mean index 1·80, Heusser.

Anorthite.—Nearly as in Albite; but plane of the axes not quite normal to the edge $I:I'$, Dx.

Oligoclase.—Nearly as in Albite; plane of the axes sensibly normal to *i-ĭ* and to the edge $I:I'$. The rings seen through the cleavage face *i-ĭ* very fine.

Cryolite.—Probably triclinic. Plane of the axes and bisectrix making an angle of about 35° with a normal to one of the cleavage faces.

2. *Negative.*

A. *Crystallization Trimetric.*

	I : I.	Plane of axes.	Bisectrix.	2V.	2E.
Iolite, Ceylon, -	119° 10′	*i-ī*	norm. *O*	∴ 69° 3′	∴ 121° 46′
" Bodenmais,		ib.	ib.	∴ 70° 4′	∴ 124° 24′
" Orrijarfvi, -		ib.	ib.	∴ 69° 57′	∴ 123° 38′
" Haddam, -		ib.	ib.	∴ 37° 48′	60° 46′!
Stilbite, - -	94° 16′	*i-ĭ*	ib.		61°, *Dx.*
Leucophane, -	91°	norm. *O*	ib.		
Mica, - - -	120° ±	*i-ĭ* & *i-ī*	ib.	0°—70°	
Talc, - - -	120° ±	*i-ī*	ib.	7° 24′, *Br.*	
Pyrophyllite, -		norm. *O*	ib.		110° ±, *Dx.*
Aragonite, - -	116° 10′	*i-ī*	ib.	∴ 17° 50′	
				obs. 18° 12′	obs. 30° 50′, *Dx.*
Witherite, - -	118° 30′	*i-ĭ*	ib.		
Alstonite, - -	118° 51′	*i-ĭ*	ib.		
Strontianite, -	117° 19′	*i-ĭ*	ib.	6° 56′	
Cerusite, - -	116° 10′	*i-ĭ*	ib.	∴ 8° 3′	∴ 16° 44′!
				obs. 8° 16′, *M.*	17° 8′, *M.*
Leadhillite, -	120° 20′	*i-ĭ*	ib.	10° 35′, *Br.*	20°, *Dx.*
Epsomite, - -	90° 34′	*O*	par. mac.	50° 52′	79° 2′, *M.*
					78° 40′, *Dx.*
Zinc Vitriol, -	91° 7′	*O*	ib.	44° 2′, *Sen.*	64° 18′, *Sen.*
					71° 20′–72°, *Dx*
Hopeite, - -	120° 26′		norm. *i-ī*.		54° ±. *Dx.*
Brookite, - -	99° 50′	*O*	par. brach.		

Index of Refraction.—*Iolite*, Ceylon, α 1·5433, β 1·5413, γ 1·5371; Bodenmais, α 1·544, β 1·541, γ 1·535; Orrijarfvi, α 1·5396, β 1·5377, γ 1·5345; Haddam, α 1·5627, β 1·5616, γ 1·5523.—*Aragonite*, α 1·68589, β 1·68157, γ 1·53013 (ray D, at 18° C.)—*Witherite*, γ 1·740, Br.—*Strontianite*, α 1·700, γ 1·543, Br.—*Cerusite*, α 2·0745, β 2·0728, γ 1·7980, Dx.; β 2·067, M.—*Leadhillite*, β ∴ 1·8828.—*Epsomite*, β 1·4817.—*Zinc Vitriol*, β 1·483–1·486.

B. *Crystallization Monoclinic.*

Orthoclase.—$I:I=118° 48'$; plane of the axes generally perpendicular to *i-ī*, inclined 21° 7′ to a normal to *ii* and 95° to a normal to *O*: sometimes this plane becomes perpendicular to the base and *parallel* to *i-ī*. Bisectrix making constantly an angle of about 5° with the clinodiagonal. An adularia from St. Gothard gave $\alpha=1·5260$, $\beta=1·5237$, $\gamma=1·5190$; whence 2V=69° 43′ and 2E=121° 6′. From

observation, 2E = 120° to 121°.—Another St. Gothard specimen, α = 1·5243, β=1·5223, γ=1·5181, whence 2V=69° 1′, 2E=119° 11′; direct observation gave 2E=119° 35′. The same specimen varies in different parts 10°. *Moonstone* identical with orthoclase.

Scolecite.—*I* : *I*=91° 36′: cleavage parallel to *i-i*; crystals usually hemitroped about *i-i*. Plane of axes perpendicular to *i-i*, making an angle of 10° to 11° with the plane of composition. Bisectrix inclined 10° to 11° to the edge (*I* : *I*). 2E=60°±.

Borax.—*I* : *I*=87°. Plane of axes normal to *i-i*, varying for the violet and red rays; for the former, inclined 108° 35′ to a normal to *O*, and 85° 10′ to a normal to *i-i*; for the latter these angles are 106° 35′ and 33° 10′. Bisectrix normal to *i-i*. Apparent mean angle 59°, Sen.—One index 1·47.

Datholite.—*I* : *I*=76° 44′, *O* : *I*=90° 4′; plane of axes parallel to *i-i*. Bisectrix sensibly normal to *O*.

Glauberite.—*I* : *I*=83° 20′, *O* : *I*=104° 15′. From 0° C. to 30° C., plane of axes normal to *i-i* and almost normal to *O*; at 30°, the two are united for white light; towards 85° C. they separate anew, but their plane is then *parallel* to *i-i*. The bisectrix preserves its primitive position. 2V varies from 0° to 3°, Brewster.

Glauber-Salt.—*I* : *I*=80° 24′, *O* : *ii*=107° 44′. Plane of axes perpendicular to *i-i*, inclined 12° 24′ to a normal to *i i*. Bisectrix normal to *i-i* and parallel to orthodiagonal; β=1·44±, Miller; 2E=80° 26′. Observed for 2E 115° to 119° 20′, which gives 78° 30′ for 2V.

C. *Crystallization Triclinic.*

Kyanite.—*O* : *i-ĭ*=100° 50′, *O* : *i-ĭ*=93° 15′, *i-ĭ* : *i-ĭ*=106° 15′. Plane of axes normal to *i-ĭ*, inclined about 30° to the edge (*i-ĭ* : *I′*). Bisectrix normal nearly to *i-ĭ*, 2V=81° 48′, Br.

D. *Appendix.*—Lepidolite of Altenberg, Margarite, Gilbertite, Astrophyllite, Antigorite, Damourite (2E=10°—12°).

Upon this subject of double refraction in minerals (and also on their dichroism), a very valuable table, containing additional details, may be found in Grailich's translation (into German) of Miller's Crystallography, entitled, "Lehrbuch der Krystallographie," published in 1856 at Vienna. The table occupies 50 pages of the work; the optical characters of many artificial salts are included in it.

Formation of Minerals.—*Daubrée* (L'Institut, 1857, 379) by subjecting glass under pressure to the action of water at a high temperature (400° C.) has changed the glass to an opaque mass consisting largely of silicate of lime (wollastonite), alkaline silicates, the excess of silica being set free, and the last forming quartz crystals. The amount of water necessary was not over half that of the glass in weight. An obsidian under the same circumstances developed *feldspar* crystals, the mass looking like trachyte; and a ferruginous glass, afforded *pyroxene*, the crystals regularly formed, transparent, and of the usual green color. Hence, ***steam under high pressure is all that is necessary in connection with the rock material of the globe to produce many of the rock crystallizations, even to the ingredients of granite.***

Descriptions of Species.

AGALMATOLITE [p. 252, 276].*—Dr. C. T. Jackson refers to agalmatolite, a rock with a soapy feel from N. Carolina (Am. J. Sci., xxiv, 273). Analysis afforded, S̈i 75·00, Ä̶l 18·75, K̇ 2·00, Ḣ 3·50=99·25, with traces of oxyd of iron.

A slate rock, resembling talcose slate from Zipser in Hungary, associated with Gabbro, afforded C. F. Chandler (Inaug. Dissert.), S̈i 75·28, Ä̶l 13·43, F̶e 1·88, Ṁg 1·79, Ṅa 0·37, K̇ 4·54, Ḣ 2·49=99·78.

The existence of aluminous slates, talcose in feel, in Canada, was shown some years since by T. S. Hunt. One afforded him (Logan's Rep., 1857, p. 448), S̈i 51·50, Ä̶l 29·20, Ḟe 9·27, Ṁg 1·08, Ṅa 1·59, K̇ 1·54, Ḣ 5·10 = 99·28.

* The paging refers to Dana's Mineralogy, and the Roman numerals, in many places added, to the preceding Supplements.

ALGODONITE, *F. Field* (Quart. J. Chem. Soc., x, 289).—The Algodonite is from the silver mine of Algodones, near Coquimbo in Chili, where it occurs in small white lumps, at first supposed to be native silver. It is coated with red oxyd of copper. Color brilliant silver-white but quickly tarnishing; fracture granular. In different trials the percentage of copper was found to be, 83·24, 83·12, 83·40, 83·36, 83·41; and of arsenic, 16·21, 16·08, 16·41, 16·24, 16·20, giving as the mean, arsenic 16·23, copper 83·30, silver 0·31=99·84. This corresponds to $Cu^{12}As$, the proportion of copper being twice that in Domeykite.

ALLANITE [p. 208, and I, II, III, IV].—D. Forbes has re-examined the orthite from the Naes Mine [see Suppl. III] about ten miles east of Arendal, where it occurs in a kind of granite consisting of quartz, mica, and two feldspars, apparently orthoclase, and some oligoclase, (Ed. N. Ph. Jour., [2], vi, 112.) Color of the orthite greenish-black; streak greenish-gray. G.=2·86 and 2·93, at 60° F. H.=6. BB. on charcoal swells, becomes brownish-yellow and fuses to a black glass. The author has redetermined the iron and proved it to be protoxyd. The following is the new statement of his analysis, and also the analysis of Strecker, which he cites from the Christiania Univ. Programme for 1854:

	$\dddot{\text{Si}}$	$\ddot{\text{Al}}$	$\ddot{\text{Bo}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Ce}}$	$\dot{\text{La}}$	$\dot{\text{Cu}}$	$\dot{\text{Y}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
1. Forbes,	31·03	9·29	3·71	20·68	0·07	6·74	4·35	*tr.*	1·02	6·68	2·06	0·90	0·56	12·24
2. Strecker,	31·85	10·28	—	19·27	—	12·76	—	0·54	—	9·12	1·86	—	—	13·37

The water in the last contained some carbonic acid. The formula deduced is $3\dot{R}^3\dddot{Si}+2\ddot{R}\dddot{Si}+10\dot{H}$ or $(\frac{3}{5}\dot{R}^3+\frac{2}{5}\ddot{R})\dddot{Si}+2\dot{H}$.

ALUNITE [p. 388].—A Silesian coal bed, according to F. Römer (Zeits. d. d. Geol. Ges., viii, 246, Lieb. u. Kopp. 1856) affords a pale straw-yellow alunite in irregular nodules; G.=2·58; contains according to Löwig, $\dddot{S}$ 34·84, $\ddot{Al}$ 33·37, $\dot{K}$ 10·10, $\dot{H}$ 18·32, $\dddot{Si}$ and organic substance 3·37, giving nearly the formula, $\dot{K}\dddot{S}+3\ddot{Al}\dddot{S}+9\dot{H}$.

ANKERITE [p. 441, and II.]—The ankerite of Lobenstein, contains, according to R. Luboldt,

$$\dot{Ca}\ddot{C}\ 51·61,\ \dot{Fe}\ddot{C}\ 27·11,\ \dot{Mg}\ddot{C}\ 18·94,\ \dot{Mn}\ddot{C}\ 2·24=99·90,$$

giving the formula $\dot{Ca}\ddot{C}+(\dot{Fe},\dot{Mg},\dot{Mn})\ddot{C}$. G.=3·01.—Pogg. cii, 455.

ANTHRACOXENE, *Reuss.*—A mineral resin from the coal beds of Brandeisl in Bohemia. According to Laurentz (Sitz. Ber., xxi, 271) it is brownish-black, but hyacinth-red in thin splinters. H.=2·5. G.=1·181. Melts easily with intumescence and burns to a slag, giving much smoke and an odor which is not disagreeable. Partly soluble in ether and not at all so in alcohol; but after a while it absorbs oxygen and then alcohol takes up a little of it. The part insoluble in ether contains 11·1 p. c. of ash. Excluding the ash, the rest contains, Carbon 75·301, hydrogen 6·204, oxygen 18·495. The atomic proportions are $C^{90}H^{38}O^{16}$. The resin of the ether solution, separated and analyzed afforded—Carbon 81·47, hydrogen 8·71, oxygen 9·82=100, corresponding to the formula $2(C^{40}H^{26}O^{3})+HO$.

APATITE.—See beyond, *Hydro-apatite.*

APOPHYLLITE [p. 304].—Daubrée states (L'Institut, No. 1246) that he has observed apophyllite in mammillary forms and stalactites rough with neat crystals, at Plombières, formed from the mineral sources; the waters contain silicates of potash and soda and have a temperature of 70° C. Wöhler has crystallized this species from water, but a temperature of 180° C. is believed to be necessary for it.

ARAGONITE [p. 448 and II, III, IV].—Hexagonal prisms, ⅜ths in. diameter, occur on the north boundary of the Creek nation, 16 miles from the crossing of the Arkansas.—W. J. Taylor, Am. J. Sci., xxiv, 275.

ASTRAKANITE or BLŒDITE [p. 379 and IV].—A massive somewhat translucent orange-colored mineral from Ischl afforded v. Hauer (Jahrb. k. k. G. Reichs., 1856, 605), as mean of results:

	$\dddot{\text{S}}$	Cl	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{Fe}}$	$\dot{\text{H}}$
1.	46·66	1·07	12·50	16·05	0·28	23·09=99·65
2.	47·69	0·31	12·12	18·00	0·08	21·50=99·70

The composition is therefore $\dot{Na}\dddot{S}+\dot{Mg}\dddot{S}+4\dot{H}$, and identical with that of Blœdite by John. G.=2·251.

Atacamite [p. 138 and I, III].—Atacamite occurs in small rhombic prisms (of the form $I.1\text{-}\breve{1}$) on malachite and quartz, at the extraordinary malachite locality in the Serra do Bembe near Ambriz on the west coast of Africa.—Phil. Mag., [4], xiii, 470.

Autunite.—See *Uranium Ores.*

Barytes [p. 366, and II].—Dr. F. Pfaff has described a fine crystal of barytes (Pogg., cii, 464) lengthened in the direction of the brachydiagonal (resembling fig. 1, p. 194 of 3d edit. of the writer's Min.), and presenting the new planes $1\text{-}4$, $i\text{-}\breve{4}$, and $\frac{1}{4}\text{-}\breve{8}$. The planes arranged according to the vertical zones are O, $1\text{-}\breve{1}$, $i\text{-}\breve{1}$; $i\text{-}\breve{4}$; $\frac{1}{4}\text{-}\breve{2}$, $1\text{-}\breve{2}$; $\frac{1}{4}$, $\frac{1}{2}$, 1, I; $i\text{-}\frac{3}{2}$; $i\text{-}\bar{2}$; $1\text{-}\bar{4}$; $\frac{1}{4}\bar{1}$, $\frac{1}{2}\text{-}\bar{1}$, $1\text{-}\bar{1}$, $i\text{-}\bar{1}$.

Beryl [p. 178 and II, IV].—A beryl from the Ural contains according to v. Kokscharov (Min. Russl., ii, 356) the plane $6\text{-}\frac{3}{2}$; inclination of the plane to a prismatic plane $=153°\ 52\frac{1}{2}'$.

Beudantite [p. 423].—According to H. Dauber (Pogg., c, 579) the crystallization of Beudantite of Levy from Ireland is rhombohedral. His measurements of crystals from (1.) Cork, Ireland, (2.) Horhausen, and (3.) Montabaur (Dernbach) in Nassau, afforded for $R:R$ (as a mean of varying results)—(1.) 91° 18′, (2.) 91° 48′, (3.) 91° 9′; the mean of all the measurements giving 91° 18′. The observed forms are, R, $-R$, $-2R$, $-4R$, $-5R$. The Montabaur crystals, which are commonly of the form $-2R$, have an easy basal cleavage.

Rammelsberg has published (Pogg. Ann., c, 579) analyses of the Beudantite of Cork, where it occurs in small green octahedrons, rust-colored externally, implanted on limonite or iron sinter. Composition (mean of results):

	$\dddot{S}$	$\ddot{\ddot{P}}$	$\ddot{\ddot{A}}s$	$\dot{P}b$	$\dot{C}u$	$\ddot{\overline{F}}e$	$\dot{H}$
	13·76	8·97	0·24	24·05	2·45	40·69	9·77 = 99·93
Oxygen,	8·26	5·10			2·21	12·21	8·68

Agreeing nearly with one of the analyses of Dr. Percy except that he found more arsenic. The oxygen ratio is nearly 9 : 5 : 2 : 12 : 9, affording the complex fomula

$$2\dot{P}b\dddot{S}+\ddot{\overline{F}}e\dddot{S}+\ddot{\overline{F}}e^{2}\ddot{\ddot{P}}+9\dot{H}.$$

F. Sandberger also describes Beudantite (Pogg., c, 611) and observes that the Dernbach crystals have the form $5R.-\frac{1}{2}R.0R$, and $5R.0R$, the last occurring also at Horhausen. $R.-R.0R$ occurs at all the localities. Color dark olive-green to clear olive-green and yellowish-green; streak yellow to greenish-yellow. Transparent to opaque. Vitreous subadamantine. H.=3·5. G=4·0018 (Dernbach). BB. on charcoal fuses, intumesces easily, and yields a lead globule containing a black magnetic mass. The Cork and Dernbach crystals contain no arsenic, while in the Horhausen, arsenic acid almost wholly replaces the phosphoric.

Analyses (mean of results) of the Beudantite of Dernbach and Horhausen:

	$\ddot{\ddot{P}}$	$\ddot{\ddot{A}}s$	$\dddot{S}$	$\ddot{\overline{F}}e$	$\dot{P}b$	$\dot{C}u$	$\dot{H}$
1. Dernbach,	13·22	*trace*	4·61	44·11	26·92	*trace*	11·44=100·30
Oxygen.	7·34		2·76	13·23	1·93		10·16
2. Horhausen,	2·79	12·51	1·70	47·28	23·43	——	[12·29]

The general formula deduced is, $\dot{P}b\dddot{S}+\dot{P}b^{3}(\ddot{\ddot{A}}s,\ddot{\ddot{P}})+3\ddot{\overline{F}}e^{2}(\ddot{\ddot{A}}s,\ddot{\ddot{P}})+24\dot{H}$. [But the oxygen ratio of the 1st analysis requires trimming to take this shape.]

Bismuthine [p. 33, 503, and I, IV].—An impure bismuth ore from Joachimsthal afforded Lindaker (Vogl's Min. Joach., p. 167) As 21·86, S 7·07, Bi 32·24, Cu 9·28, insoluble part 27·50, water 1·32=99·37. H.=5. G.=5.

Bismutite [p. 462, and IV].—Occurs at Joachimsthal (Vogl's Min. Joach., p. 168) amorphous massive, in small pieces, of a dull mountain-green, pearl gray or straw-yellow color, and vitreous lustre; H.=1—4·5. With the Bismutite, there are small crystals of what is regarded as a new carbonate of bismuth. It is siskin-green and clove-brown; and the crystals are thin longish prisms, translucent and vitreous. It contains, according to Lindaker, oxyd of bismuth, silica, carbonic acid and water. Effervesces in acids. BB. fuses to a brownish-black pearl, and gives a bismuth globule with soda, coloring the coal yellow on using the oxydation flame.

BLENDE [p. 45. and II].—Analysis of a black blende from Clausthal in dodecahedral crystals, G =4·07, by C. Kuhlemann (Zeits. f. d. g. Nat., viii, 499, Lieb. u. Kopp, 1856), S 33·04, Zn 65·39, Fe 1·18, Cu 0·13, Cd 0·79, Sb 0·63=101·06.

BOURNONITE [p. 80].—Mean of two analyses of the bournonite of Clausthal by C. Kuhlemann (Zeits. f. d. g. Nat., viii, 500, in Lieb. u. Kopp, 1856, p. 834)

S	Sb	Pb	Cu	Fe	Mn	Quartz
18·81	23·79	40·24	12·99	2·29	0·17	2·60=100·88

The manganese and part of the iron may be a mixture.

CALCITE [p. 405, 503, and I, II, III, IV].—Dark brown crystals from Naeskul near Arendal afforded D. Forbes (Ed. New Ph. J., [2], vi, 119), $\dot{C}a\ddot{C}$ 98·39, $\dot{F}e\ddot{C}$ 0·79, $\dot{M}n\ddot{C}$ 0·23, $\bar{\bar{A}}l$ 0·38, $\dddot{P}$ *tr.*, insol. 0·21=100.

Crystals of calcite in calcite are described by Kenngott in Pogg., cii, 309, 310, 311.

The limestone of the Boracic acid region in Tuscany (Eocene "Calcare Alberese") contains according to Dr. C. Schmidt (Ann. d. Ch. u. Pharm., cii, 190) as follows: one variety, from near Suffioni, of 69·20 carbonate of lime, 0·18 carbonate of magnesia, and 30·07 silica and silicates, of which 26·06 are of silica, with $\bar{\bar{A}}l$ 0·95, $\bar{\bar{F}}e$ 0·71, $\dot{F}e$ 0·35, $\dot{M}n$ 0·08, $\dot{M}g$ 1·45, $\dot{N}a$ 0·11, $\dot{K}$ 0·36. A second variety from Mt. Cerboli, consists of 66·57 $\dot{C}a\ddot{C}$, 1·22 $\dot{M}g\ddot{C}$, with 24·44 silica, along with $\bar{\bar{A}}l$ 2·17, $\bar{\bar{F}}e$ 2·05, $\dot{F}e$ 0·86, $\dot{M}n$ 0·35, $\dot{M}g$ 1·15, $\dot{N}a$ 0·19, $\dot{K}$ 0·21. The Serpentine mentioned beyond in this Supplement is from the same region.

CASSITERITE [p. 118].—Fine crystals of Tin ore occur at Pitkaranta, Finland, which according to A. E. Nordenskiold (Pogg., ci, 637) have the planes O, $\frac{1}{4}$, 1, $\frac{5}{2}$, 5, I, $\frac{1}{4}$-3, 3 $\frac{3}{2}$, i-$\frac{3}{2}$, i-$\frac{4}{3}$, 1-i, i-i; and to these, he states that M. Gadolin adds, $\frac{2}{3}$, 7, $\frac{18}{7}$ $\frac{18}{16}$, $\frac{17}{6}$-$\frac{17}{13}$, $\frac{7}{2}$-$\frac{7}{4}$, $\frac{4}{2}$ $\frac{8}{4}$, $\frac{7}{6}$-$\frac{3}{2}$, 1-3, i-$\frac{7}{5}$, i-$\frac{11}{8}$, i $\frac{8}{7}$, i-$\frac{5}{4}$, i-$\frac{6}{5}$, i-$\frac{7}{6}$, i-$\frac{8}{7}$, i-$\frac{11}{10}$, i-$\frac{14}{13}$, i $\frac{32}{31}$; but there is doubt as to some of these planes, as these unusual ratios were determined from measuring angles alone, and not through zones. The measurements afforded, 1 : 1=121° 42′ and 92° 56′, vertical axis =0·6720.

CHALCODITE [p. 500, and IV].—A description and analyses of Chalcodite are published by G. J. Brush in this volume (Am. J. Sci., [2], xxv, 198). There are two varieties, a greenish-bronze and a brass-yellow; H.=1; G.=2·76. The green variety afforded on analysis:

	$\dddot{S}i$	$\bar{\bar{A}}l$	$\bar{\bar{F}}e$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a, \dot{K}$	$\dot{H}$
1.	45·06	3·56	38·85	——	*trace*	*trace*	4·55	*trace*	
2.	45·51	3·68	38·61	——	*trace*	0·28	4·57		9·22
3.			20·92	16·04					
4.			20·02	16·91					
5. Mean,	45·29	3·62	20·47	16·47	*trace*	0·28	4·56	*trace*	9·22=99·91

giving the formula $2\dot{R}\dddot{S}i+\bar{\bar{R}}\dddot{S}i+3\dot{H}$. In Nos. 1 and 2 the iron was weighed as sesquioxyd, while in 3 and 4 special determinations of the relative amount of protoxyd and sesquioxyd were made. Prof. Brush shows that the composition approaches that of Stilpnomelane, (of which he cites the analyses), and observes that a new analysis of the latter especially with reference to the state of oxydation of the iron, is needed to decide as to the identity. The chalcodite is in exceedingly delicate micaceous scales grouped into a drusy concretionary crust; and it is suggested that this delicacy of structure may account for its more ready decomposition with acids than stilpnomelane. Some rectangular tables made up of the chalcodite look like pseudomorphs.

CHEROKINE of Shepard [III, IV].—T. S. Hunt has examined a specimen of Cherokine sent him by Prof. C. U. Shepard, and found (Am. J. Sci., xxiv, 275) that it is *phosphate of lead* (*pyromorphite*), with less than one per cent of a whitish precipitate which may have been phosphate of lime or alumina. The mineral was in milk-white prisms.

CHLORITE (including Pennite, Ripidolite, Clinochlore, Leuchtenbergite) [p. 295, 296, and I, II, III, IV].—The Pennine and Leuchtenbergite, examined by Descloiseaux [see Suppl. IV], he regards as uniaxal or rhombohedral (Ann. d. M., xi, 261).

The crystals of pennine are acute rhombohedrons truncated at the extremities and often tabular. The *positive*, of Ala and Zermatt, have $R:R=65° 28'$, $O:R=103° 45'$ and $76° 15'$, as taken with the reflecting goniometer. They are sometimes in twins parallel to the base, having a bipyramidal form, though tabular. *Negative* pennine from Zermatt, gave Descloizeaux $R:R=63° 15'$, $O:R=100° 30'$; but the difference may be accidental, as the faces of the latter are not quite smooth. The bluish, bluish-green and transparent crystals of Zermatt and the Tyrol are *negative*, and the deep green of Zermatt and especially Ala are *positive:* but some plates of the latter appear to be neutral and hardly let the polarized rays pass. The *Leuchtenbergite* is *positive* and the same in type with *positive* pennine.

The *Clinochlore* of Achmatowsk, he observes, has the angle of 50° between the optical axes. The axes in the species are *positive*. He refers to clinochlore, the hexagonal chlorite of Pfitsch, Pfunders and Zillerthal in the Tyrol, which occurs in bipyramidal hexagonal compound crystals. Angles between O and planes on the acute basal angle in a common vertical zone, 108° 14′, 120° 21′, 125° 42′, 128° 35′, 133° 46′. *Tabergite* also has the optical characters of clinochlore; also specimens, not yet analyzed, from Marienberg. For optical characters see page 399 of this Supplement.

The *chlorite of Traversella*, analyzed by Marignac, according to Descloizeaux is a talcose clinochlore; he has detected optically that a *negative* talc-like substance forms its centre and a *positive*, like clinochlore, its border. A similar mineral is found at Taberg, and at Brosso in Piedmont. The last, according to Damour, contains

$\ddot{\mathrm{Si}}$ (by diff.)	$\bar{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{H}}$
33·67	20·37	29·49	6·57	10·10

The large proportion of alumina suggests to him that this may be a distinct species.

The name *Ripidolite* was given by von Kobell to a green chlorite in grouped folia, occurring with crystals of adularia and quartz at St. Gothard, at Rauris in the Grisons, and at Zillerthal in the Tyrol. The double refracting power is feeble; it is distinctly *positive*, and the axes make an angle with one another of about twenty degrees. BB. it fuses on the edges to a black and very magnetic enamel. The *scaly chlorite* analyzed by Marignac has the same composition and similar appearance; it occurs in nests in the valley of Bourg-d'Oisans, at the Mountain of the Sept-Lacs, between Allevard and Allemont, in the granites around Chamouni, and elsewhere in the Alps.

Descloizeaux recognizes three groups of Chlorite, and adopts for them the names Pennine, Clinochlore and Ripidolite.

Chloritoid [p. 298].—The following are the analyses hitherto made of the Katharinenburg chloritoid (see von Kokscharov, Min. Russ., ii, 357). 1, 2, O. L. Erdmann (J. f. pr. Ch., 1835, iv, 127, vi, 89 [called *chlorite-spar* in Min., p. 298]); 3, Gerathewohl (J. f. pr. Chem., 1845, xxxiv, 454); 4, v. Bonsdorff (G. Rose's Reise n. d. Ural, 1837); 5, R. Hermann (J. f. pr. Ch., 1851, liii, 18); 6, v. Kobell (ib., 1853, lviii, 40):

	$\ddot{\mathrm{Si}}$	$\bar{\mathrm{A}}\mathrm{l}$	$\bar{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{H}}$		
1.	24·90	46·20	——	28·89	——	——	——	= 99·99	Erdmann.
2.	24·96	43·83	——	31·21	——	——	——	=100·00	Erdmann.
3.	24·40	45·17	——	30·29	——	——	——	= 99·86	Gerathewohl.
4.	27·48	35·57	——	27·05	0·30	4·29	6·95	=101·64	v. Bonsdorff.
5.	24·54	30·72	17·28	17·30	——	3·75	6·38	= 99·97	R. Hermann.
6.	23·01	40·26	——	27·40	——	3·97	6·34	=100·98	v. Kobell.

Hermann suggests that the chloritoid analyzed by Erdmann (and afterwards by Gerathewohl, who took pieces from the same specimen) had been burnt at the mine, where they burn the stone for separating the emery, and he thus accounts for the absence of water.

Von Kobell's analysis gives the same composition that he obtained for the Bregratten chloritoid. [The ratio between the oxygen of the bases and silica (water excluded) is 1 : ½, the staurotide ratio, and the fact that there are simple alumina silicates in which the ratios ½ and ⅔ occur is sufficient reason for admitting them in the formulas of the chlorite series of minerals. The formula of chloritoid is either $(\dot{R}^3, \bar{R})\ddot{Si}^{\frac{1}{2}}+Aq$, or $(\dot{R}^3, \bar{R})\ddot{Si}^{\frac{2}{3}}+Aq$.—J. D. D.]

CINNABAR [p. 48, and II, IV].—Circular polarization has been observed in Cinnabar by M. Descloizeaux (Ann. d. M. xi, 261), quartz having hitherto been supposed to be alone among minerals in this respect. Its refraction is *positive* (instead of negative, as Brewster stated), the index of ordinary refraction being 2·854, of extraordinary 3·201. Its rotatory power is fifteen or sixteen times that of quartz. It is remarkable, as Descloizeaux observes, that its crystals are never plagihedral.

CLINOCHLORE.—See *Chlorite.*

COLUMBITE [p. 353, and II, IV].—R. Hermann, in J. f. pr. Chem., lxx, 397, makes objection to the conclusion of Oesten cited in our last Supplement, p. 115.

CONDURRITE.—See *Domeykite.*

DOMEYKITE [p. 36].—F. Field observes (Quart. J. Chem. Soc., x, 289) that Condurrite appears to be an *arsenite of copper* of the formula $\dot{C}u^3\dddot{A}s$, which has resulted from the alteration of Domeykite (Cu^6As). The mean from nine samples of Condurrite examined by Blyth, gave for the proportion of arsenic and copper, As 28·84, Cu 71·15. The Domeykite of great brilliancy and purity from the Cordilleras of Copiapo afforded Field, As 28·44, Cu 71·56; and another from Coquimbo, As 28·26, Cu 71·48, corresponding to Cu^6As.

DUFRENOYSITE [p. 77, and I, II, III, IV] (Binnite of some authors).—Von Waltershausen has reviewed again the composition of this mineral (Pogg., c, 537) with the following results. Analyses 1 and 2 by Nason, 3 and 4 by Uhrlaub:

	S	As	Pb	Ag	Fe
1.	23·54	25·14	51·48	0·17	0·08=100·41
2.	23·82	23·81	51·65	0·12	——= 99·40
3. (G.=5·074)	24·659	23·324	51·188	0·025	——= 99·191
4. (G.=5·459)	24·046	23·948	51·397	0·024	——= 99·415

The first analysis gives the atomic ratio for the sulphur, arsenic, and other metals 11·7 : 5·3 : 4·0. As the ratio gives no satisfactory formula, the composition is regarded, as in von Waltershausen's former memoir, a compound of $PbS+As^2S^3$ (Arsenomelan), and $2PbS+As^2S^3$ (Scleroclase), the ratios between which in the analyses he has calculated.

ELIASITE.—See *Uranium Ores.*

EPIDOTE [p. 206, and II, III, IV].—R. Hermann has re-calculated the oxygen proportions for the analyses of epidote (J. f. pr. Chem., lxx, 321), and shows that the ratio 1 : 2 for the protoxyds and peroxyds is far from uniform, whether the iron be taken as protoxyds or peroxyds, while in either case there is a remarkably uniform ratio of 1 : 1, between the oxygen of the sum of the bases, and that of the silica and water. In 11 analyses by Hermann the oxygen ratio for $\dot{R}$, $\ddot{\text{R}}$, $\dddot{\text{Si}}$, $\dot{\text{H}}$, varies between 1 : 1·53 : 2·44 : 0·24, and 1 : 2·01 : 2·77 : 0·37: or, if the iron be peroxyd, between 1 : 1·73 : 2·60 : 0·26, and 1 : 2·55 : 3·44 : 0·24. In 12 other analyses by Stockar-Escher, Scheerer and Rammelsberg, taking the iron as peroxyd, the same ratio varies between 1 : 2·15 : 2·89 : 0·31 and 1 : 2·37 : 3·04 : 0·32. The general formula ($\dot{R}^3$, $\ddot{\text{R}}$)$\dddot{\text{Si}}$ (the water being in general included with the silica) covers the whole, excepting a part of the water, in some varieties. Hence the general formula (translating that by Hermann, who writes $\dddot{\text{Si}}$ for silica) is ($\dot{R}^3$, $\ddot{\text{R}}$)$\dddot{\text{Si}}$+$n\dot{R}\dot{\text{H}}$.

Idocrase has similar but smaller variations, according to Hermann, from the accepted ratio 3 : 2 : 5. But all conform to the general formula ($\dot{R}^3$, $\ddot{\text{R}}$)$\dddot{\text{Si}}$+$n\dot{\text{H}}$.

[These species are placed in the Mineralogy under the general formula ($\dot{R}^3$, $\ddot{\text{R}}$)$\dddot{\text{Si}}$ (p. 155 and 183). While there is little doubt of the variations, yet it appears to be well established by the analyses, that in epidote, the variations are variations about 1 : 2 : 3 as the *normal* ratio, and in idocrase, about 3 : 2 : 5, as the *normal* ratio of the species. Hermann writes the epidote formula, ($\dot{R}$ $\ddot{\text{R}}$)$^2\dddot{\text{Si}}$ + $n\dot{R}\dot{\text{H}}$, regarding rightly $\ddot{\text{R}}$ as replacing $\dot{R}$; but according to any natural or proper mode of reading it, the formula as it stands, implies 8 of oxygen in the bases to 2 in the silica, instead of 2 in each as he means.—J. D. D.]

Orthite crystals occur at Laurinkari near Abo, according to A. E. Nordenskiöld (Pogg., ci, 635) along with Scapolite. Color pure black; lustre vitreous; streak uncolored. H.=6·5. G.=3·425. Form long prismatic or tabular. Axes a : b : c (b

being the clinodiagonal and *c* the orthodiagonal) = 0 8588 : 1 : 0·5503. $1\text{-}i : \frac{1}{2}\text{-}i$ = 154° 34′, $1\text{-}i : 2\text{-}i$ = 150° 17′, $1\text{-}i : 1$ = 125° 25′, $I : 1$ = 151° 18′. C (or $a : b$) = 64° 18′.
Hessenberg has observed on crystals from Zermatt and St. Gothard the new planes $2\text{-}\frac{4}{3}$, $\frac{1}{5}$, $-\frac{1}{2}$, $-\frac{1}{4}$, -7, $-7\text{-}7$, $\frac{1}{3}\text{-}i$ (Lieb. u. Kopp, 1856, p. 849).

Erythrine or Cobalt Bloom [p. 416].—Analysis of a specimen from Joachimsthal by Lindaker (Vogl's Min. Joach., p. 160):

$\dddot{\text{A}}\text{s}$	$\dddot{\text{S}}$	$\dot{\text{C}}\text{o}$	$\dot{\text{N}}\text{i}$	$\dot{\text{F}}\text{e}$	$\dot{\text{C}}\text{a}$	$\dot{\text{H}}$
36·42	0·86	23·75	11·26	3·51	0·42	23·52 = 99·74

giving the usual formula.

Euchroite [p. 421].—A mineral, not yet determined, but resembling euchroite has been observed by Kenngott (Pogg., cii, 308) along with the Dioptase of the Kirghis steppes. Color fine emerald-green, and lustre vitreous. Crystals 2 millimetres high and thick; trimetric; planes I, $i\text{-}\bar{i}$, O, $m\text{-}\bar{i}$, $1\text{-}\bar{i}$; the prism I near 120°, the summit angle of the dome $1\text{-}\bar{i}$ nearly a right angle, that of $m\text{-}\bar{i}$ more obtuse. Planes I vertically striated.

Eukolite [p. 342, and I, IV].—Descloizeaux states on crystallographic and optical grounds (Ann. d. M., xi, 261) that Eukolite is rhombohedral and near Eudialyte, but has a *negative* axis, while Eudialyte has a *positive* one.

Faroelite or Mesole [p. 328, and IV].—According to Dr. Heddle (Phil. Mag., [4], xv, 28), the globules of faroelite from Faröe (cave in Naalsöe) consist of crystals; and he has found on measurement that they are right rectangular prisms, with highly perfect pearly cleavage, stilbite-like, parallel to one of the lateral faces of this prism. There are planes on the edges of the prism, and they are inclined to the cleavage face at the angle 116° 20′. Calling these planes $i\text{-}\bar{2}$, the cleavage is brachydiagonal (parallel to $i\text{-}\bar{i}$); and $i\text{-}\bar{2} : i\text{-}\bar{2}$ = 127° 20′ and 52° 40′, $i\text{-}\bar{2} : i\text{-}\bar{i}$ = 116° 20′. The form is related to those of Stilbite and Thomsonite. [The corresponding angle in Stilbite is 130° 12′; in Thomsonite 127° 28′.] The oxygen ratio of Thomsonite, for $\dot{\text{R}}$, $\ddot{\text{R}}$, $\dddot{\text{S}}\text{i}$, $\dot{\text{H}}$ is 1 : 3 : 4 : $2\frac{2}{3}$; for Faroelite 1 : 3 : 5 : $2\frac{2}{3}$.

Fichtelite [p. 472].—A memoir on this species is published in the Ann. d. Ch. u. Pharm., Aug. 1857, ciii, 236; and also, revised by the author, in this volume (Am. J. Sci., xxv, 164).

Garnet [p. 190, and I, II, III, IV].—A whitish compact garnet rock occurs in the Green Mountains to the north, along with euphotides, according to Prof. T. S. Hunt (Logan's Canada Geol. Rep., and Phil. Mag., [4], xiv, 388). It is distinguished from Euphotide by its specific gravity, which is 3·3—3·5. It is mixed with serpentine and has a feeble waxy lustre, a hardness of 7·0; a yellowish or greenish white color. Composition according to Hunt (Logan's Rep., 1847, p. 447):

	$\dddot{\text{S}}\text{i}$	$\ddot{\text{A}}\text{l}$	$\dot{\text{C}}\text{a}$	$\dot{\text{M}}\text{g}$	$\dot{\text{F}}\text{e}$, $\dot{\text{M}}\text{n}$	$\dot{\text{N}}\text{a}$, $\dot{\text{K}}$	ign.	
1. Orford,	38·70	22·71	34·83	0·49	1·60	0·47	1·10 = 99·90.	G. = 3·522–3·536

A related rock, from St. François, was found to correspond in composition to 57·72 garnet and 40·71 pyroxene.
The species Sodalite, Hauyne, Nosean, Ittnerite and Helvin are referred to the Garnet type by Hermann (J. f. pr. Chem., lxx, 334). [This relation of Helvin is recognized in the Min., p 194 and Suppl. I; and the similar ratio of 1 : 1 between the bases and silica in these species and garnet; and the accessory character of the chlorid and sulphates in the sodalite series, is also remarked upon in the chapter on the Classification of Minerals, vol. i, p. 244].

Gold.—Native gold has been found on Clarke's fork of the Columbia river, a few miles above Fort Colville.

Glaubersalt [p. 386, and II].—Occurs with Hayesine in cavities in the Gypsum of Nova Scotia.—*H. How*, Am. J. Sci., xxiv, 230. Analysis afforded, Sulphate of soda 44·54, water 55·46.

Haidingerite [p. 413].—Vogl states (Min. Joach., p. 186) that Joachimsthal was probably the original locality of the Haidingerite.

HARMOTOME [p. 328].—Found in crystals at Petersberge in the Siegengebirge.—Verh. Nat. Ver. d. preuss. Rheinl. und Westph., p. ci.

HAYESINE or *Natro-boro-calcite*, [p. 394 and III].—Prof. H. Haw describes (Am. J. Sci. [2], xxiv, 230) a locality of this species in the gypsum of Nova Scotia. It occurs in narrow veins with glauber-salt and in the substance of the gypsum partly in mammillated masses, which on being broken present the appearance of a finely fibrous silky lustrous mass brilliantly white in color. $G.=1·65$. $H.=1$. Tasteless. Analysis of the *air-dried* mineral:

Boracic acid 44·10, Lime 14·20, Soda 7·21, Water 34·49,

whence he gives the formula $\dot{\mathrm{Na}}\ddot{\mathrm{B}}^{2}+\dot{\mathrm{Ca}}^{2}\ddot{\mathrm{B}}^{3}+15\dot{\mathrm{H}}$; the composition is identical with that obtained by Ulex, except 5 per cent more water, arising from his using the air-dried mineral.

HYALOPHANE [I, III].—Hyalophane has been referred by Heusser to Orthoclase (see Suppl. III. under Feldspar). Von Waltershausen has published (Pogg., c., 548) another analysis by Mr. Uhrlaub, as follows:—

$\overline{\mathrm{Si}}$	$\dddot{\mathrm{S}}$	$\overline{\mathrm{Al}}$	$\dot{\mathrm{Ba}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
45·65	4·12	19·14	21·33	0·77	0·73	0·49	8·23	0·54

It differs widely from the former one, in which von Waltershausen found 24·127 of silica and 49·929 of alumina. Specific gravity of the transparent variety 2·805, the translucent 2·901.

HYDRO-APATITE, *Damour*.—Hydro-apatite is a hydrous apatite described by M. Damour (Ann des Mines, [5], x. 65). It comes from the Pyrenees, where it is found in the fissures of a ferruginous argillaceous rock of a brown color. It occurs in mammillary concretions, semitransparent, and looking a little like chalcedony. $H.=5·5$. $G.=3·10$. Heated in a tube it decrepitates and disengages ammoniacal water. Analysis afforded:

$\dddot{\mathrm{P}}$	$\dot{\mathrm{Ca}}$	Ca	F	$\dot{\mathrm{H}}$
40·00	47·31	3·60	3·36	5·30

with 0·43 of phosphate of iron. Formula $\dot{\mathrm{Ca}}^{3}\dddot{\mathrm{P}}+\frac{1}{3}\mathrm{CaF}+\dot{\mathrm{H}}$. The same schist not far off affords wavellite.

IDOCRASE—See under *Epidote*.

ILMENITE [p. 115, and II].—Hexagonal tables from the chlorite slate of Harthau near Chemnitz, afforded O. Hesse (Lieb. u. Kopp, 1856, p. 839), TiO^{2} 52·52 and $\overline{\mathrm{Fe}}$ 47·48; another 53·50 and 47·22.

Analysis of Ilmenite from the gold sands of Antioquia by Damour (Ann. Ch. Ph., li, 445):

	$\ddot{\mathrm{Ti}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$
1. Rio Chico,	57·09	42·11	0·80 = 100
2. Cienaga,	48·14	50·17	1·69 = 100

JOHANNITE.—See *Uranium ores*.

KAOLIN [p. 249, 506]—A kaolin from an important bed at Zettlitz near Karlsbad in Bohemia, afforded Dr. A. Bauer (Sitz. Wien, xxii, 693), Free quartz 53·40, silica 15·82, soluble silica 6·65, alumina 17·48, $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 0·40, $\overline{\mathrm{Fe}}$ 0·24, $\dot{\mathrm{Mg}}$ and $\dot{\mathrm{K}}$ *trace*, water expelled near 100°—150° C. 0·38, at ignition 5·60. This gives the percentage, $\overline{\mathrm{Si}}$ 48·61, $\overline{\mathrm{Al}}$ 38·90, $\dot{\mathrm{H}}$ 12·47=99·98, and the formula $\overline{\mathrm{Al}}\,\overline{\mathrm{Si}}^{2}+2\dot{\mathrm{H}}$.

Scheerer has published (Pogg., xc, 320) the following analysis by R. Richter of a kaolin pseudomorph after prosopite: Silica 45·63, alumina 39·89, water 13·70, lime 0·60=99·82.

KAPNICITE, *Kenngott*.—A hydrous sulphate of alumina occurring with Felsobanyite at Kapnik in Hungary and named Kapnicite by Kenngott (Min. Forsch., 1855). It is found in small radiated feathery rounded concretions, the needles apparently rhombic prisms with acute edges replaced, and low pyramidal terminations; color yellowish or greenish-white. Lustre vitreous: $H.=3·5$—4. Composition according to a very uncertain analysis (on account of employing only 90 milligrams) by von Hauer, Sulphuric acid 6·20, alumina 75·75, water (from the loss) 18·55. [In the form of the crystals, and also in the constituents, there is some approximation to Diaspore.—J. D. D.]

KENNGOTTITE.—A species mentioned as probably new by Kenngott in Pogg., xcviii, 165, [see Suppl. III, under Freislebenite,] is thus named by Haidinger (Sits. Wien, xxii, 236). It has the following characters in addition to those mentioned in Suppl. III. Color iron-black to lead gray; the acute angle of the rhombic basal plane 42°, which gives for the obtuse angle 138°; inclined axis of the prism lies in the plane bisecting the obtuse angle. According to von Hauer it contains more silver than Miargyrite, which species it most resembles. The crystals are grouped irregularly. They come from Felsöbanya in Hungary.

LAUMONTITE [p. 307, and IV].—The zeolite from the island of Skye, referred to in the 4th Supplement, p. 121, has been analyzed by Prof. S. Haughton (Phil. Mag., [4], xiii, 509). He regards it as the *hypostilbite* of Beudant, having obtained for its composition—

$\bar{\text{Si}}$	$\bar{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
52·40	17·98	9·97	0·36	0·08	1·40	17·83=99·97

LEUCITE [p. 231, and III].—Analyses of crystals; 1, 2, from Lake Laach, 3, 4, from Vesuvius eruptions of 1845 and 1847 by Bischof (Lehrb. Geol., ii, 2288, Lieb. u. Kopp, 1856, p. 851), and 5, 6, 7, by Rammelsberg of eruption of Vesuvius of 1845 (Pogg., xcviii, 142):

$\bar{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	ign.	
56 22	23 07	0·48	0·23	6·40	13 26	? = 99·66	
54·36	24·23	——	——	3 90	16·52	0·64= 99·65	
57·84[a]	22·85	0·14	0·20	6·04	12·45	0 59=100·11	
56·49	22·99	——	0·04	3·77	15·21	1·48= 99·98	
56·24	23·02	——	——	0 56	19·88	0·52=100·22.	G.=2·48
56·05	23·16	——	——	0·30	20·04	0·52=100·07	
57·15	23·24	——	——	0 63	19·46	0·52=101·00	

[a] Containing some Iron.

Rammelsberg did not find the large proportions of soda obtained by Bischof. A white partially altered leucite (having G.=1·82), from Rocca Monfina, northwest of Naples, afforded Rammelsberg the same composition. Another kind is a kaolin, one specimen containing $\bar{\text{Si}}$ 53·39, $\bar{\text{Al}}$ 25·07, $\dot{\text{Ca}}$ 0·28, $\dot{\text{K}}$ 0 64, $\dot{\text{Na}}$ 11·94, $\dot{\text{H}}$ 9·26.

The leucite altered to glassy feldspar mentioned by Scacchi and Blum, according to Rammelsberg (loc. cit.) is partly decomposed by muriatic acid, and the soluble and insoluble parts, analyzed separately afforded

		$\bar{\text{Si}}$	$\bar{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$
Soluble	1.	18·39	12·11	0·56	0·17	5·50	4·10=10·83
	2.	24·00	12·47	0·71	——	5·25	2 86=45·29
Insoluble	1.	[39 91]	11·69	0·40	——	0 30	6·84=59·14
	2.	[34·78]	11·58	——	——	*trace*	8 64=55·0

He concludes that it consists of nepheline and orthoclase, and this is sustained on mineralogical grounds by G. Rose. It corresponds to about 4 of nepheline and 7 of orthoclase.

LEUCHTENBERGITE.—See *Chlorite.*

LIEBIGITE.—See *Uranium ores.*

LÖWEITE [p. 501].—A reddish variety of this mineral from Ischl afforded v. Hauer (Jahrb. k. k. Reichs. 1856, 605):

$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\bar{\text{Fe}}$	$\dot{\text{H}}$	NaCl
52 53	14·31	18·58	*trace*	14·80	*trace*=100·22

MARCASITE [p. 60, and III].—A tin-white ore from Schneeberg which had been called *Weisskupfererz*, has been analyzed by von Kobell (J. f. pr. Ch., lxxi, 159) and found to be Marcasite, containing a little copper and arsenic. Analysis afforded S 48·93, Fe 43·40, Cu 3·0), As 0·67, Quartz 4·00=100. He regards it as marcasite mixed with a little mispickel and chalcopyrite. *Lonchidite* reacts like this ore, and so also *Kyrosite.*

Mispickel [p. 62, 509, and I, II, III].—Analysis of an ore from the coal formations of Merseburg by Baentsch (Zeits. f. d. g. Nat., vii, 372, Lieb. u. Kopp. for 1856):

As 38·23 S 21·70 Fe 35·97 $\dddot{S}i$ 3·27 $\dot{M}g$, $\dot{C}a$ *trace*=99·17. G.=5·36—5·66.

Baentsch writes the formula $3FeS^2+2FeAs$.

Monazite [p. 402].—Crystals from the gold sand of Rio Chico in Antioquia afforded Descloizeaux (Ann. Ch. Ph., li, 445) the following angles: $I:I$ (in front) =93° 20′, over the side 86° 35′; $I:i\text{-}i$=136° 30′; $O:i\text{-}i$ (behind) =76° 15′; -1 : -1=107° (nearly); -1 : -1-i=143° 40′; $i\text{-}i$: -1i=127° 0′; O : -1·i=129° 30′. Damour obtained for the composition (ib.)

$\dot{\dot{P}}$ 28·60 $\dot{C}e$ 45·70 $\dot{L}a$ 24·10 insol. in $\dddot{S}$ 1·60=100,

whence the oxygen ratio of base and acid 3 : 5, and the formula $(\dot{C}e, \dot{L}a)^3\dot{\dot{P}}$. No thoria could be detected.

E. Zschau has described (in Allg. deutsche Nat. Zeit., Dresden, 1857, p. 208) a crystal of Monazite from Helle, Norway, measuring a square inch on one of its sections. It gives him the angles, C=77° $I:I$=92°—93°, O:-1-i=130° O:-1=121°, O: 1-i=138°, O: 2-i=119°. M. Zschau observes that in crystallization the *Urdite* is nothing else than Monazite.

Naphtha [p. 469, and II].—The Burmese Naphtha or Rangoon Tar has been analyzed by Warren de la Rue and Hugo Müller.—See Phil. Mag., [4], xiii, 514.

Orthoclase [p. 242, and I, II, III].—Breithaupt has described (Berg. u. hutt. Zeit., xvii, 1) a twin crystal of orthoclase, in which the face of composition is parallel to the plane 1.

The *Chesterlite* is pronounced by Breithaupt (ibid.) to be pericline [a variety of albite. He seems to be unaware that in 1854, Smith and Brush analyzed the species (see Am. J. Sci., [2], xvi, 42, and Min., p. 243) and proved it to be identical in composition with orthoclase. Its angles are very varying.]

The feldspar crystals, of a pale fawn-colored feldspathic intrusive rock, occurring at Richelieu, Canada, and the paste of the rock, afforded T. S. Hunt (Logan's Rep. Canada, 1857, p. 486):

	$\dddot{S}i$	$\dddot{A}l$	$\dddot{F}e$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	ign.
1. Crystals,	66·15	19·75	——	0·95	5·19	7·53	0·55=100·12
2. Paste,	67·60	18·30	1·40	0·45	5·85	5·10	0·25= 98·95

Pennine.—See *Chlorite.*

Phenacite [p. 189].—The following forms have been observed in Russian crystals by von Kokscharov: R, $-R$, $-\frac{1}{2}R$, $-2R$; $\frac{2}{3}$-2, $-\frac{2}{3}$ 2, $\frac{4}{3}$-2; $\frac{r}{l}\frac{3}{2}\text{-}\frac{3}{2}$, $\frac{l}{r}\frac{3}{2}\text{-}\frac{3}{2}$, $\frac{r}{l}3\text{-}\frac{3}{2}$; prisms I, i-2; these forms are hemihedral as referred to the rhombohedron or tetrahedral referred to the hexagonal prism. Many excellent figures are given, several of them containing each 9 of these forms. The crystals from the emerald and chrysoberyl mine of Katharinenburg are sometimes near 4 inches across; and one weighs nearly 1½ pounds. Cleavage is distinct parallel to i-2, hardly so parallel to R. G.=2·966—2·996 v. Kokscharov. Its fracture is like that of quartz. It has been found also in small crystals, on the east side of the Ilmen Mountains, 5 wersts north of Miask, with topaz and green feldspar. The following are the observed angles (mean of closely agreeing results): $R:R$=116° 35½′, $R:I$=127° 22′, $R:i$-2=121° 41′, $R:-R$=74° 44½′, $\frac{2}{3}$-2 : $\frac{2}{3}$-2=156° 45′, R : $\frac{2}{3}$-2=159° 54½′, R : -2R=160° 35½′. By calculation, from axis a=0·661065, $R:R$=116° 36′, $R:I$=127° 21½′, R : i 2=121° 42′, R : -R=74° 42½′, $\frac{2}{3}$-2 : $\frac{2}{3}$-2=156° 44′, R : $\frac{2}{3}$-2=159° 56′; R : -2R=160° 35′, R : -½=148° 18′.

Pitchblende.—See *Uranium ores.*

Prosopite [p. 502, and I, II].—The species Prosopite, which had been known for some time as a kaolin pseudomorph, was first described by Scheerer (Pogg., xc, 315, 1853) as homœomorphous with Barytes (Heavy Spar) and after some imperfect trials, he suggested that the formula of the unaltered mineral was CaF+AlF³+Aq, under the idea of this homœomorphism and on the assumption that such a formula

was analogous to $BaO+SO^3$. In this Journal (vol. xvii, p. 452) and the Mineralogy (p. 502), the writer showed that there was no near relation in form to Barytes, while the resemblance in angles and monoclinic aspect to Datholite was very close. In 1854, Scheerer published further on the subject (Pogg., xcii, 612, 1854) retaining the above formula for the Altenberg prosopite, but making the Schlackenwald a phosphate, and giving for its formula (without having made a quantitative analysis)

$$\left.\begin{matrix}\dot{R}^3\ddot{\ddot{P}} \\ R\ F\end{matrix}\right\} + AlF^3 + y\dot{H}.$$

In 1855, Prof. G. J. Brush, while at Freiberg, received from Mr. Zschau a large number of crystals of the prosopite, and made the very important observation (published in this Journal, xx, 273) that while many crystals had been kaolinized, others consisted of violet fluor, and others still of fluor partly kaolinized. The writer examined many of the crystals sent him by Prof. Brush, detected the octahedral cleavage of fluor, and observed that the fluor was a pseudomorph as well as the kaolin. The nature of the original mineral still remained undetermined. Some of Prof. Brush's specimens were vitreous and subtransparent, but the amount was too small for him to analyse.

Recently, Scheerer has described the prosopite anew (Pogg., ci, 361). He gives the following, as the mean of many trials (see figure in Min., and this Jour., xx, 274), $i2:i2=76\frac{1}{2}°$, $2:2=133°\ 30'$, $2\bar{i}:2\bar{i}=116\frac{1}{2}°$, $2\bar{3}:2\bar{3}=120°\ 56'$. The approximation to datholite and herderite in angles is about equally close, while in monoclinic habit it is nearer the latter. Hardness 4·5; G.=2·890, 2·898. Colorless to white. In a glass tube affords water and fluorid of silicon. Decomposable by sulphuric acid. In the analysis, the fluorid of silicon was determined by the difference between the total loss in heating the mineral in a Sefström's furnace and the amount of water lost in heating a mixture of the mineral with oxyd of lead. Scheerer thus obtained (taking his final results as given in the appendix to his paper)—

$\ddot{\bar{A}}l$	$\dot{C}a$	$\dot{M}n$	$\dot{M}g$	$\dot{K}$	SiF^3	$\dot{H}$
42·68	22·98	0·31	0·25	0·15	10·71	15·50=92·58

(The potash here included is given in the earlier statements of the analysis, but is overlooked afterwards.) The loss of 7·57 p. c. is regarded as proving that 5·60 p. c. of the oxygen is replaced by fluorine. The mineral is thence supposed to contain $6\ddot{\bar{A}}l$, $1SiF^3$, 5CaF, $1\dot{C}a$, $12\dot{H}$, or, differently arranged, $5\ddot{\bar{A}}l$, $1AlF^3$, $1SiF^3$, 2CaF, $4\dot{C}a$, $12\dot{H}$. Scheerer makes out the following formula:

$$\left.\begin{matrix}1CaF,\ SiF^3 \\ 1CaF,\ AlF^3 \\ 1\dot{C}a\ddot{\bar{A}}l\end{matrix}\right\} + 3\dot{C}a\ddot{\bar{A}}l + (\dot{H})\ddot{\bar{A}}l + 9\dot{H};\ \text{or}\ \left.\begin{matrix}1CaF,\ SiF^3 \\ 1CaF,\ AlF^3\end{matrix}\right\} + 4\dot{C}a\ddot{\bar{A}}l + (\dot{H})\ddot{\bar{A}}l + 9\dot{H},$$

which he says is unlike that of datholite; it may also be added that it is very unlike that of Heavy Spar and all other examples of formulas that we are acquainted with, and we may well wait for more light.

Pyrophyllite [p. 303, and I].—Descloizeaux has observed (Ann. d. M., xi, 261) that the bisectrix of the optical angle is normal to the face of the cleavage, and therefore the crystallization is not oblique. He makes it triclinic, with the cleavage diagonal.

Pyrosclerite [p. 291, and III].—According to Descloizeaux (Ann. d. M., xi, 261) the Kæmmererite of Siberia, which occurs in violet hexagonal plates on chromic iron, has probably two axes of feeble double refraction, the optic axes quite distant, the bisectrix *positive.* He thinks it may be a mixed mineral, like the Traversella chlorite (see under Chlorite). Better crystals are needed to decide positively as to whether it has one or two optical axes.

Pyroxene [p. 158, and I, II].—*Uralite*, according to M. de Richthofen (Sitz. Acad. Vienna, L'Institut, 1858, 21), as it occurs near Predazzo, is a pseudomorph produced in the wet and not the dry way.

The *diallage* of a diallage rock associated with serpentine in Orford, Canada, has the following characters according to T. S. Hunt (Logan's Rep. Geol. Canada, 1857, p. 443). H.=5. G.=3·02–3·03. Color celandine-green. Translucent. Contains some magnetic iron in grains; a chlorite-like mineral occurs between the masses of

diallage. Composition of (1) the pure mineral (mean of two analyses), (2) the rock, and (3) of the pale bronze diallage of another diallage rock, in Ham:

	$\dddot{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\dot{\text{Ni}}$, $\bar{\text{Cr}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
1.	47·15	3·45	8·73	*trace*	24·56	11·35	5·82 = 101·06
2.	41·80	6·80	11·05	*trace*	26·13	7·00	7·60 = 100·38
3.	50·00	——	13·59	——	27·17	3·80	6·30 = 100·86

RENSSELAERITE.—See *Talc.*

RIPIDOLITE.—See *Chlorite.*

RUTILE [p. 120].—Von Kokscharov describes in his Min. Russl., ii, 352, a peculiar variety of rutile from the phenacite and topaz mine of the Ilmen Mts., which has the form of the fundamental octahedron, without any prismatic planes. He names it *Ilmenorutile.* It is iron black in color, opaque, or slightly red on the edges of some small crystals in the sunlight; crystals sometimes 0·4 in. in breadth. H. above 6. G. 5·074, v. Kokscharov, 5·133, v. Romanwosky. Composition (approximate) according to R. Hermann, Titanic acid 89·30, sesquioxyd of iron 10·70=100.

SALT [p. 90, and II, III, IV].—Composition of brine springs of Cheshire, England; Aug. B. Northcote.--Phil. Mag., [4], xiv, 457.

SCAPOLITE [p. 201, and I, II].—Von Kokscharov in his Min. Russl. ii, 304, remarks upon the identity of Glaucolite and Scapolite. Glaucolite is from the vicinity of the river Sludianka beyond Lake Baikal, Siberia. G.=2·65—2·67. H.=5—6. Color indigo-blue. Occurs massive. Von Rath obtained for the Glaucolite (mean of results):

$\dddot{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$	$\dot{\text{Ca}}\ddot{\text{C}}$
46·01	26·72	1·49	15·68	0·46	0·56	4·57	0·47	1·68=97·64

A soft yellowish white opaque pseudomorph from Christiansand, Norway, is described by Kenngott, in Pogg., cii, 308, but no analysis is given.

SCOLECITE [p. 328, and I, IV].—R. Hermann states (J. f. pr. Ch., lxxii, 26) that he took a white amorphous plastic mass from a crevice in the columnar basalt of Stolpen in Saxony, and put it away in a box. After a long time, on opening the box, he found there—not the amorphous mass, but a group of white acicular crystals which had all the aspect of Scolecite.

Descloizeaux states (Ann. d. M., xi, 261) that the crystals of *Mesolite* are compound; but in other respects the mineral does not differ from Scolecite. He was not able on account of the twin nature of the crystals to determine their optical characters.

SERPENTINE [p. 282, and I, II, III, IV].—The Serpentine rocks of Canada have been carefully studied and analyzed by Prof. T. S. Hunt (see Logan's Rep. 1857, and this Jour., xxv, 217). He adopts for the rocks the name *ophiolite.* The purer serpentine rock, being *normal* ophiolite, and other varieties, named *calcareous, dolomitic* and *magnesitic* ophiolite, according as the rock contains calcite, dolomite or magnesite intimately mixed with the serpentine. The following are the analyses of three Canada serpentines and another from Syracuse, New York:

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Ni}}$	$\bar{\text{Cr}}$	$\dot{\text{H}}$ (ign.)
1. Orford.	40·30	[39·07]	7·02	0·26	*trace*	13·35=100
2. Brompton Lake,	42·90	36·28	7·47	0·15	0·25	13·14=100·19
3. Bolton, *fibrous*,	43·70	40·68	3·51	*undet.*	——	12·45=100·34
4. Syracuse,	40·67	32·61	8·12	$\bar{\text{Al}}$ 5·13	——	12·77= 99·30

For other analyses of the ophiolite rocks, see this volume, p. 217. These rocks are shown to contain more or less talc, diallage and other accessory ingredients, and these are separated in the analytical process.

The serpentine of Syracuse, New York, occurs in beds of the Onondaga Salt Group, between unaltered strata (see Vanuxem's N. Y. Geol. Rep. p. 108-110, and Logan's Rep. for 1853-56, 1857, p. 474). The color of the serpentine is blackish green to greenish white, and some bronze-colored diallage occurs sparingly in it.

Mr. Hunt states (ib. p. 472) that he has detected nickel and chrome in the serpentine of the Green Mountains generally; of Roxbury, Vt.; New Haven, Ct.; Hoboken, N. J.; a locality in California; Cornwall, Eng.; Banffshire, Scotland; Vosges, France; and that Hermann observed it in the pyrosclerite of Pennsylvania, and Brush in antigorite (a true slaty serpentine) from Piedmont, and in Williamsite, a serpentine from Pennsylvania. No nickel, Mr. Hunt announces, is contained in any of the ophiolites of the Laurentian rocks (metamorphic rocks older than Silurian); none in a pale greenish-yellow serpentine from Easton, Pa., G.=2·501; a wax yellow from Montville, N. J.; olive-green from Phillipstown, N. Y.; yellowish green from Newburyport, Mass., probably of Devonian age, and G.=2·551.

The Serpentine rock and limestone of the vicinity of the boracic acid fumaroles in Tuscany have been analyzed by Dr. C. Schmidt (Ann. d. Ch. Pharm., cii, 190). The unaltered serpentine of two localities contained—

	$\ddot{Si}$	$\ddot{C}$	$\bar{Al}$	$\bar{Cr}$	$\bar{Fe}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Cu}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
1.	37·10	0·58	2·81	0·44	5·25	4·62	0·21	0·16	30·97	2·56	0·25	0·19	12·84
2.	37·94	*tr.*	0·96	0·33	4·75	3·99	0·23	0·21	36·69	0·80	0·14	0·09	13·44

with also traces of boracic and phosphoric acids and chlorine, and in the first 2·51, in the second 1·06 p. c. of water driven off near 100° or 110° C.

NATIVE SILVER [p. 15, and III].—Silver has been observed at Joachimsthal as a pseudomorph after Silver glance; and also Red Silver ore as a pseudomorph after native silver.

SILVER GLANCE [p. 37, and I].—An imperfectly crystallized silver glance from Joachimsthal afforded Lindaker (Vogl's Min. Joach., p. 78), Sulphur 14·46, silver 77·58, iron 2·02, copper 1·53, lead 3·68, affording the formula AgS = Sulphur 12·96, silver 87·04. The alteration of the silver glance produces a mixture called silver-black (Silberschwärze).

SMALTINE [p. 56, 511, and II].—The nickel ore called Chloanthite and the Smaltine from Joachimsthal have been analyzed as follows by F. Marian (Vogl's Min. Joach., pp. 143 and 158):

	As	S	Co	Ni	Fe	Cu	
1. Chloanthite,	71·47	0·58	3·62	21·18	2·83	0·29=99·97.	G.=6·28—6·89
2. Smaltine,	74·52	1·81	11·72	1·81	5·26	1·06=99·72.	G.=6·807

STILBITE [p. 332, and III].—Stilbite crystals from the Nerbudda valley, Hindostan, afforded Prof. S. Haughton (Phil. Mag., [4], xiii, 510):

$\ddot{Si}$	$\bar{Al}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$
56·59	15·35	5·88	0·82	0·89	1·45	17·48 = 98·46

SVANBERGITE [Suppl. II].—Transparent to translucent crystals have been examined by H. Dauber (Pogg., c, 579), the form of which is rhombohedral, having the planes R and $4R$, and a distinct basal cleavage. $R:R$ (mean of many measurements) 90° 35′, $R:4R$=154° 30′. Form near that of Beudantite (see Beudantite, this Supplement).

TALC [p. 275].—Delesse has analyzed different *potstones* with the following results (Ann. des Mines, [5], x, 333): 1, from Drontheim, Norway,—deep green, containing some dark green chlorite and titanic iron; 2, from Potton, Lower Canada,—grayish-green, containing some chlorite; 3, from Chiavenna, Switzerland—grayish-green, containing talc, and some chlorite, titanic iron, and carbonate of magnesia and iron; 4, from Kvikne, Norway,—grayish-green, fibro-lamellar in structure, and containing a little magnetic iron and some carbonate of magnesia and iron; 5, from Kutnagherry, India,—gray, schistoid, with some lamellæ of chlorite and talc:

	$\ddot{Si}$	$\bar{Al}$	$\bar{Fe}$	$\dot{Mg}$ (by loss)	$\dot{Ca}$	$\dot{H}$	$\ddot{C}$
1.	27·53	29·65[1]		[29·27]	1·50	12·05	——
2.	29·88	29·53		[28·32]	0·77	11·50	——
3.	36·57	1·75	5·85	[35·39[2]]	1·44	4·97	14·03
4.	38·53	3·55	8·20	[31·45]	4·02	4·25	10·00
5.	47·12	8·07	3·82	[32·49]	——	8·50	——

[1] with a little titanic oxyd. [2] with a little protoxyd of manganese.

Rensselaerite.—T. S. Hunt obtained on analysis for the Rensselaerite of Grenville, Canada, and also for crystals from Canton, N. Y. (Logan's Rep. 1857, p 454):

$\ddot{S}i$ 61·60	$\dot{M}g$ 31·06	$\dot{F}e$ 1·53	$\dot{H}$ 5·60 = 99·79
61·10	31·63	1·62	5·60 = 100·05

Its composition is that of talc. H.=2·5—3·0. G.=2·757. Texture granular. Color greenish white to pale sea-green. Translucent. Powdered mineral soapy in feel.

[The crystals, according to Beck, have the form of pyroxene, after which species, according to him, they are pseudomorphs.—J. D. D.]

A yellowish white earthy mineral, somewhat resembling aphrodite, fills fissures in the rensselaerite of Grenville which afforded Hunt, $\ddot{S}i$ 46·66, $\dot{M}g$ (by diff.) 38·05, $\dot{F}e$ 1·33, loss by ignition 13·96. It takes a waxy lustre under the nail.

TANTALITE [p. 351, and III, IV].—The Tantalite of Skogböle in Kimito and Härkäsaari in Tamela has been studied by A. E. Nordenskiöld (Pogg., ci, 625) and shown to belong to two species. The Tamela tantalite is that which has been figured [see Min., p. 231], and for which the name *tantalite* is retained. It was called Skogbölite by A Nordenskiöld. It occurs both near Härkäsaari in Tamela and Skogböle in Kimito. It is submetallic, black, with a blackish-brown to cinnamon-brown powder. H.=6—6·5. G.=7·8—8·0, some specimens 7·3–7·4.

Composition according to E. A. Nordenskiöld of a specimen from Skogböle, Tantalic acid 84·44, oxyd of tin 1·26, oxyd of copper 0·14, $\dot{F}e$ 13·41, $\dot{M}n$ 0·96, $\dot{C}a$ 0·15 =100·36.

Berzelius obtained for a Tantalite with "cinnamon-brown powder" [No. 2 in Min.], $\dddot{T}a$ 85·85, $\ddot{S}n$ 0·80, $\dot{F}e$ 12·97, $\dot{M}n$ 1·61, lime 0·56, silica 0·72=102·51; G.=7·655 (Afh. i Fys., etc, iv, 266, and vi, 237).

The other species (the Kimito-Tantalite of N. Nordenskiöld) is named IXIOLITE. It has been found only at Kimito near Skogböle. Crystallization trimetric, and usually in rectangular prisms, in which O, i-$\bar{\imath}$, i-$\bar{\imath}$, are prominent planes. $I:I$=122° 18½′, $O:1$-$\bar{\imath}$=128° 45′, $O:3$-$\bar{\imath}$=104° 58·6′, $O:1$=111° 9·9′, $1:1$-$\bar{\imath}$=125° 13·9′, $1:i$-$\bar{\imath}$= 132° 26·8′, 1 : 1 (pyr. edges) 95° 6·4′ and 70° 27·8′, basal edge 137° 40·2′. Composition parallel to ½-$\bar{\imath}$. H.=6—6·5. Specific gravity 7—7·25, mostly 7·05—7·1. Lustre weak metallic; color blackish-gray to steel-gray. Streak brown. BB. unchanged, but with borax and salt of phosphorus dissolves easily with an iron and manganese reaction. Composition probably, Tantalic acid 72·51, oxyd of tin 12·79, protoxyd of iron 7·38, ib. manganese 7·32. Wornum's analysis is stated to have been made upon a mixture of the two species.

The vertical axis in Tantalite is to that of Columbite as 4 : 3. Ixiolite approximates in form to Tantalite if its shorter lateral axis be increased one-half.

TETRAHEDRITE [p. 82, and I, II].—Analysis of the ore (1) from Clausthal, and (2) Andreasberg, by C. Kuhlemann (Zeits. f. d. g. Nat., viii, 500, Lieb. u. Kopp, 1856, p. 834):

	S	Sb	As	Ag	Cu	Fe	Zn
1.	25·54	27·64	——	3·18	34·59	6·23	3·43=100·61
2.	25·22	27·38	0·67	1·58	37·18	3·94	5·00=100·97.

TURQUOIS [p. 405].—W. P. Blake refers to this species a hard green stone known among the ancient Mexicans as *Chalchihuitl* (Am. J. Sci., [2], xxv, 227). It comes from the mountains called *Los Cerillos*, southeast of Santa Fé, where it occurs in crevices in nests. H.= nearly 6. G.=2·426—2·651. Trials by J. M. Blake showed that in its constitution it was related to Turquois.

UIGITE, *Heddle.*—This name has been suggested by Dr. Heddle (New Ed. Phil. J., [2], iv, 162) for a *supposed* new mineral from near Uig in Skye. It occurs with Faroelite and Analcime, in nests in the amygdaloid. It is in sheafy plates, somewhat resembling in structure a plumose mica, and intermediate in appearance between faroelite and gyrolite. Color white, slightly yellowish; lustre pearly; H.= 5·5, brittle; G.=2·284. B.B fuses readily and quietly to an opaque enamel which is not frothy, giving a strong soda reaction. Analysis afforded—

$\ddot{S}$	$\bar{\bar{A}}l$	$\dot{C}a$	$\dot{N}a$	$\dot{H}$
45·98	21·93	16·15	4·7	11·25

URANIUM ORES.—Vogl has published the following on the Uranium ores of Joachimsthal in his Min. Joach., p. 95.

Pitchblende [p. 107, and IV].—A black variety from the Elias mine has G.=7·08—7·23. F. Marian.

Johannite [p. 386].—In a glass tube at a low heat does not change; highly heated gives water and sulphurous acid and becomes brown and finally black. BB. on charcoal, gives sulphur fumes and a scoria of black color and dull green streak. Analysis according to Lindaker (mean of two trials):

$\dddot{S}$	$\dot{U}\,\dddot{\bar{U}}$	$\dot{Cu}$	$\dot{Fe}$	$\dot{H}$
20·02	67·72	5·99	0·20	5 59=99·52

Hence the formula $2(\dot{U}\,\dddot{\bar{U}})\dddot{S}+\dot{Cu}\dddot{S}+4\dot{H}=\dddot{S}$ 19·37, $\dot{U}\,\dddot{\bar{U}}$ 68·40, $\dot{Cu}$ 6·43, $\dot{H}$ 5·80=100.

[The formula might be written $\dot{Cu}^2\dddot{S}+2\dot{U}^3\dddot{S}+6\dddot{\bar{U}}\,\dddot{S}+12\dot{H}$, and correspond either to $8(\frac{1}{4}\dot{U}^3+\frac{3}{4}\dddot{\bar{U}})\dddot{S}+\dot{Cu}^2\dddot{S}+12\dot{H}$, or $\dot{R}^3\dddot{S}+2\dddot{\bar{R}}\,\dddot{S}+4\dot{H}$ —J. D. D.]

Basic Sulphate.—Occurs in soft globular and nodular coatings, earthy in appearance, of a pistachio or verdigris green color, and pale or apple-green streak. There is a lime and a copper variety. Lindaker obtained for each:

	$\dddot{S}$	$\dot{U}\,\dddot{\bar{U}}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{Cu}$	$\dot{H}$
1. Lime var.,	12·34	79·50	1·66	0·12	——	5·49=99·11
2. Copper var.,	12·13	79·69	0·05	0·36	2·24	5·25=99·72

Whence the formula $2(\dot{U}\,\dddot{\bar{U}})^3\dddot{S}^2+(\dot{Ca},\dot{Cu})\dddot{S}+10\dot{H}$. [This formula may be written $3\dddot{\bar{U}}^2\dddot{S}+(\dot{U}^3)^2\dddot{S}+(\dot{Cu},\dot{Ca})\dddot{S}+10\dot{H}$, or, regarding the sulphate of copper and lime as unessential $(\frac{1}{4}\dot{U}^3+\frac{3}{4}\dddot{\bar{U}})^2\dddot{S}+Aq$. On the view here taken, the Johannite comes under the general formula $(\dot{R}^3,\dddot{\bar{R}})\dddot{S}+Aq$, and the basic sulphate, under the formula $(\dot{R}^3,\dddot{\bar{R}})^2\dddot{S}+Aq$. In the former the ratio of $\dot{R}^3$ to $\dddot{\bar{R}}$ is 1 : 2, in the latter 1 : 3.

Eliasite [p. 108, 505].—Eliasite is near Pitchblende, but is regarded by Vogl as distinct. No new analysis is given.

Liebigite [p. 461].—The species near Liebigite, described by Vogl as a *Uran-kalk-carbonat*, (Min., p. 462,) afforded Lindaker the following as a mean of three analyses:

$$\ddot{C}\ 23·86 \quad \dot{U}\ 37·11 \quad \dot{Ca}\ 15·56 \quad \dot{H}\ 23·34=99·87.$$

whence the formula $\dot{U}\ddot{C}+\dot{Ca}\ddot{C}+5\dot{H}=(\dot{U},\dot{Ca})\ddot{C}+2\frac{1}{2}\dot{H}$. The action of carbonated waters on the sulphates produces these carbonates.

Uranochalcite or *Urangreen* [Min., p. 386].—In small nodular crusts and velvety druses consisting of acicular crystallizations. Color fine grass-green to apple-green. Composition according to Lindaker (mean of two analyses):

	$\dddot{S}$	$\dot{U}\,\dddot{\bar{U}}$	$\dot{Cu}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{H}$
Analysis,	20·03	36·14	6·55	10·10	0·14	27·16
Calculated,	20·35	35·95	6·73	9 50		27·47

The calculated result corresponding to the formula $\dot{U}\,\dddot{\bar{U}}+\dot{Cu}\dddot{S}+2\dot{Ca}\dddot{S}+18\dot{H}$.

Zippeite or *Uranbloom* [p. 461].—There are two varieties, a copper var. and one without copper: the former fine sulphur-yellow in delicate needles or acicular rosettes or warty crusts; the latter lemon to orange-yellow. Analyses:

	$\dddot{S}$	$\dddot{\bar{U}}$	$\dot{Fe}$	$\dot{Cu}$	$\dot{Ca}$	$\dot{H}$
1. Copper var.,	17·361	62·042	——	5·208	——	15·232=99·843
2. Without copper,	13·063	67·855	0·172	——	0·607	17·693=99·390

The former affords the formula $\dot{Cu}\dddot{S}+\dddot{\bar{U}}^3\dddot{S}^2+12\dot{H}$; and the latter $\dddot{\bar{U}}^3\dddot{S}^2+12\dot{H}$. It contains no carbonic acid.

Uranochre [p. 461].—Amorphous earthy or scaly and of a fine lemon-yellow color; a second variety is orange-yellow. Analysis by Lindaker:

	$\dddot{S}$	$\dddot{\bar{U}}$	$\dot{Cu}$	$\dot{Fe}$	$\dot{H}$
First variety,	7·116	70·936	0·235	0·413	20·880=99·578
Second variety,	10·165	66·052	——	0 863	20·057 $\dot{Ca}$ 2·622=99·759

whence the formula for the first, $3\dddot{\bar{U}}^3\dddot{S}+14\dot{H}$; for the second, $\dot{Ca}\dddot{S}+2\dddot{\bar{U}}^3\dddot{S}+28\dot{H}$. Another less pure variety contains oxyd of lead and manganese.

The preceding uranium ores are all from Joachimsthal.

Autunite [p. 430, and IV, under *Uranite*].—According to Descloizeaux (Ann. d. M., xi, 261) $I:I$ in Autunite is probably 93° or 94° (see 4th Suppl., p. 180).

URDITE.—See *Monazite.*

VOLTZINE [Min., p. 127].—Lindaker obtained for a specimen from Joachimsthal (Vogl's Min. Joach., p. 175), sulphuret of zinc 82·75, oxyd of zinc 17·25=100.

WITHERITE [p. 449].—Dr. Heddle has analyzed Thomson's *sulphato-carbonate of baryta* from Dufton and Hexham, which he observes is only the carbonate encrusted more or less with minute crystals of the sulphate. He obtained (Phil. Mag., [4], xiii, 537):

	$\dot{Ba}\ddot{C}$	$\dot{Ba}\dddot{S}$	$\dot{Ca}\ddot{C}$
1. Dufton,	99 24	0·54	0·22 = 100
2. Hexham,	98·96	0·94	*trace*= 99·90

WULFENITE [p. 349, II.].—Crystals from Antioquia gold sands gave Descloizeaux the angles (Ann. Ch. Ph., [3], li, 448) $O:1\text{-}i=122°\ 32'$, $O:\frac{1}{2}\text{-}i=142°$, $1\text{-}i:\frac{1}{2}\text{-}i=160°\ 10'$, $1\text{-}i:1\text{-}i$ (basal) $=115°\ 10'$, $O:1=114°\ 20'$, $1:1$ (basal) $=131°\ 40'$. [In the Mineralogy, $O:1\text{-}i=126°\ 26'$ should be $122°\ 26'$.]

ZEOLITES.—Damour has found (Comptes Rend., May, 1857, L'Institut, 1857, 168) that the zeolites, analcime excepted, have the property of losing a large part and sometimes all of the water of combination they contain, when placed in an atmosphere completely dried, or when heated to between 40° C. and a low red heat; and that after this partial dehydration, they will absorb the full amount of water again, when exposed in the open air; also that the facility with which they part with the water is in proportion to the water they contain. The heat proper for success with each species should not be exceeded. The results are regarded as confirming the conclusion that the zeolites were formed in the wet way.

Appendix.

BERYL.—The Emerald of Muso, the famous emerald mine of New Granada, has been analyzed anew by M. Lewy (L'Institut, No. 1247), as follows:

	$\ddot{Si}$	$\bar{\bar{Al}}$	$\bar{\bar{Be}}$	$\dot{Mg}$	$\dot{Na}$
1.	68·0	18·1	12·2	0·9	0·7
2.	67·7	17·8	12 6	0·9	0·6

Traces of chromium are reckoned with the magnesia, and perhaps there is a little titanic acid with the alumina. In previous trials, he had found water as follows: 2·13, 1·67, 1·93, 2 06, 1·65, 2·15, 1·67; and from the 1st, 3d, 4th and 6th of these, he obtained 0·35, 0·21, 0·25, 0·3 carbonic acid, corresponding to some organic matter present, the 1st by calculation giving C 0·09, H 0·05; the *second* 0·06 and 0·03; the third 0·07 and 0·04; the fourth 0 08 and 0·05. The author thinks that the color depends on the organic matter, as it was deepest in those affording the most of it, and was removed at a low red heat.

The mine of Muso (four miles west of Muso) is in lat. 5° 39′ 50″ N., and 76° 45′ west of Paris, in the Eastern Cordillera of the Andes, about 75 miles north-northeast of Bogota. The crystals often crack to pieces after being removed for a while from the mine, apparently from losing water. The rock is a limestone containing ammonites. The limestone contains $\dot{Ca}\ddot{C}$ 47·8, $\dot{Mg}\ddot{C}$ 16·7, $\dot{Mn}\ddot{C}$ 0·5, silica 24·4, $\bar{\bar{Al}}$ 5·5, $\bar{\bar{Be}}$ 0 5, $\bar{\bar{Fe}}$ 2·6, pyrites 0·6, alkali 2·7=101·2.

EUCLASE.—Von Kokscharov reports the important discovery of Euclase in the gold region of the Southern Ural, in the Orenburg district, near the river Sanarka. One transparent crystal is 24 millimeters in length and 13 by 7 in its other directions.—Bulletin k. k. geol. Reichs. Wien, Feb. 23, 1858.

ERRATA.—In Suppl. IV, under LIEVRITE and COLUMBITE, 5th line in each *brachyd.* should be *macrod.*; and under PARASTILBITE, the angle $2\text{-}\breve{2}:2\text{-}\breve{2}$ should probably be $I:I$; it is very near $I:I$ in Heulandite.

ART. XXXVI.—*On the effects of Initial Gyratory Velocities, and of Retarding Forces, on the Motions of the Gyroscope;* by Major J. G. BARNARD, A.M., Corps of Engineers, U.S.A.*

IN one of the concluding paragraphs of my first paper on the Gyroscope (Am. Journal of Science, July, 1857) I stated that "an initial impulse may be applied to the rotating disk in such a way that the horizontal motion shall be absolutely without undulation. An initial angular velocity such as would make its corresponding deflective force equal to the component of gravity $g\sin\theta$, would cause a horizontal motion *without* undulation."

The statement contained in the last sentence quoted, is not rigidly true; for *besides* the component of gravity, there is another force to be considered, viz., the centrifugal force due to the gyratory velocity, which acts either in conjunction with, or in opposition to, the component of gravity, according as the axis of the disk is above or below a horizontal.

In this last position this force is null (as regards its effects in sustaining or depressing the axis), and to *this* angular elevation of the axis the statement quoted is true without qualification. The assumption of an initial horizontal velocity requires only a new determination of constants for equations (*a*) and (*c*) (pp. 53, 54, July No.).

If we make, in those equations

$$\theta=\alpha,\ \varphi=90^\circ,\ \psi=90^\circ,\ a=-\sin\alpha,\ v_x=m,\ v_y=0,\ v_z=n,$$

(in which m is the assumed initial velocity) and determine the constants h and l therefrom, the equations of motion will become

$$\left.\begin{aligned}\sin^2\theta\frac{d\psi}{dt}&=\frac{Cn}{A}(\cos\theta-\cos\alpha)+m\sin\alpha\\ \sin^2\theta\frac{d\psi^2}{dt^2}+\frac{d\theta^2}{dt^2}&=\frac{2Mg\gamma}{A}(\cos\theta-\cos\alpha)+m^2\end{aligned}\right\}\quad(1)$$

and from them we get

$$\sin^2\theta\frac{d\theta^2}{dt^2}=\left[\frac{2Mg\gamma}{A}\sin^2\theta-\frac{2Cmn}{A}\sin\alpha-\frac{C^2n^2}{A^2}(\cos\theta-\cos\alpha)\right.$$
$$\left.-m^2(\cos\theta+\cos\alpha)\right](\cos\theta-\cos\alpha)\quad(2)$$

From this we get $\frac{d\theta}{dt}=0$ when $\cos\theta-\cos\alpha=0$; and as $\frac{d\psi}{dt}$ is not zero for this initial elevation, it indicates, instead of a cusp, a tangency to the horizontal here.

If the curve described is horizontal without undulation, the other factor of the second member of eq. (2) should likewise become zero with $\theta=\alpha$: an effect which may ensue from a suitable value given to m.

* This paper is intended to give a more rigidly mathematical demonstration of the effects of "retarding forces" than is given in Art. X. (January No.) of this Journal; and to give the theory of the "motions" of the Gyroscope a more general form, by the introduction of "Initial Gyratory Velocities."

The value of the deflecting force due to a given angular velocity m is (p. 64, July number) $\frac{C}{\gamma M}mn$, and if we suppose this equal to the component of gravity $g \sin\alpha$, we shall have $m = \frac{Mg\gamma}{Cn} \sin\alpha$.

If we substitute this value of m in the second member of equation (2) and assume $\alpha = 90°$ the factor in question becomes zero for $\theta = \alpha$, and the maximum and minimum values of θ are the same, indicating a horizontal motion without undulation.

For every other initial elevation than 90° a different value of m is required to produce this result, in consequence of the influence of the centrifugal force of gyration at other elevations.

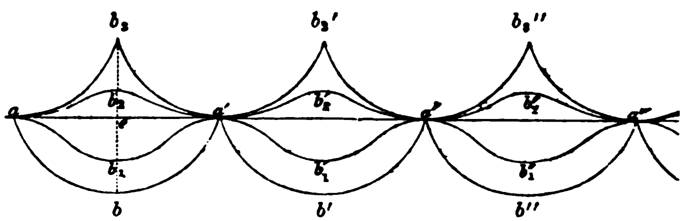
With $\alpha = 90°$, equation (2) becomes

$$\sin^2\theta \frac{d\theta^2}{dt^2} = \left[\frac{2\,Mg\gamma}{A}\sin^2\theta - \frac{2\,Cmn}{A} - \frac{C^2n^2}{A^2}\cos\theta - m^2\cos\theta\right]\cos\theta \quad (3)$$

Placing the first factor of the second member equal to zero and solving with reference to $\cos\theta$ we get (recollecting the value given to β in our former article)

$$\cos\theta = -\beta^2 - \frac{Am^2}{4\,Mg\gamma} + \sqrt{\left(\beta^2 + \frac{Am^2}{4\,Mg\gamma}\right)^2 + 1 - \frac{Cmn}{Mg\gamma}}. \quad (4)$$

I.



For $m = 0$, equation (3) expresses the cycloidal curve with cusps a, a', a'', &c., as has been already shown in our former investigation. For $m > 0$ but $< \frac{Mg\gamma}{Cn}$ the minimum value of θ derived from equation (4) is greater than when m is zero, while instead of a cusp (there is as has already been observed) a tangency at a, and the curve has the wave form $ab_1\ a'b'_1$ (the points $b_1\, b_1'\, b_1''$, &c. being higher than $b\,b'\,b''$).*

When $m = \frac{Mg\gamma}{Cn}$ the curve unites with the horizontal $a\,a'\,a''\,a'''$ and there is no undulation; equation (4) giving $\cos\theta = 0$, or $\theta = 90°$.

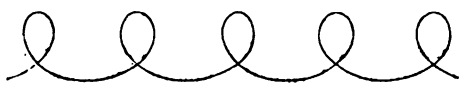
* In reality, the *amplitudes*, $a\,a'$, $a'\,a''$, of the undulations become increased, at the same time that the sagittæ are diminished, but, for the sake of comparison, I have represented them the same for each variety of curve.

When $m > \frac{Mg\gamma}{Cn}$, $\frac{d\theta}{dt}$ becomes still zero with $\theta = \alpha = 90°$; but this instead of a maximum is now a *minimum* value of θ, for the value of θ which satisfies equation (4) is greater than 90°, and the curve $a b_2$ $a' b_2'$, &c., undulates *above* the plane $a a' a''$.

Finally when $m = \frac{2\,Mg\gamma}{Cn}$, equation (4) will give $\cos\theta = -\frac{1}{2\beta^2}$ and a substitution of this in the first equation (1) (making $\alpha = 90°$), will give $\frac{d\psi}{dt} = 0$: showing that the curve makes cusps at its superior culminations, and that the common cycloidal motion is resumed. In fact the value of $\frac{d\psi}{dt} = \frac{1}{\beta}\sqrt{\frac{g}{\lambda}}$ (p. 59, July number) at the *lowest* point b of the cycloid, is, (substituting the values of β and λ) exactly equal to $\frac{2\,Mg\gamma}{Cn}$, and the value of the sagitta u corresponding to $e b$ is what we have just found for $\cos\theta$, or $e b_3$, viz. $\frac{1}{2\beta^2}$.

If now, retaining m constant at this value to which we have brought it, we increase the rotary velocity, n, or vice versa, a curve *with loops*, (fig. 2,) may be described, as it can be shown that, for the maximum value of θ, $\frac{d\psi}{dt}$ becomes negative.*

2.



In my supplementary paper in the January number of this Journal I have endeavored to show how the theoretical cycloidal motion of a simple solid of revolution is modified by the retarding forces of friction and the resistance of the air, and to show that the theory explains all the phenomena observed in the ordinary gyroscope.

It may be objected however that the nature of the curve given in Fig. 1, (p. 69,) is in some degree *assumed*, and I therefore wish to show that it can be confirmed by mathematical demonstration.

The rotary velocity n of the disk is supposed to be gradually destroyed through the retarding forces of friction at the extremities of the axle, and of the resistance of the air at the surface.

Without attempting to give analytical expressions for the retarding forces, it is sufficient to say that the rotary velocity, at the end of any

* The above corresponds, if I am correctly informed, to a case described by Prof. Peirce, at the meeting of the American Association at Montreal.

If m is made *negative* and small (i. e., a *backward* initial velocity given) a looped curve like the above, but lying *below* the plane $a a' a''$, results. All these curves (n being always supposed very great) are but the different forms of the "cycloid" known as *prolate*, *common*, and *curtate* cycloids; the common—a *particular* case of the curve—corresponding to the *particular* case of the problem in which the initial gyratory velocity is either zero or has the *particular value* $\frac{2\,Mg\gamma}{Cn}$.

time t, counting from the commencement of motion, may be expressed thus

$$n-f(t)^*$$

in which n is the *initial* rotary velocity of the disk.

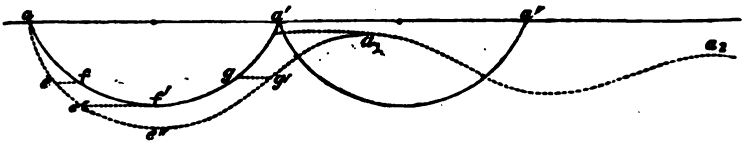
If we substitute this expression for v_z in the last two equations (3) (p. 53, July No.,) and follow a similar process to that by which equations (4) of that paper are deduced, we shall get, for the equations of motion

$$\left.\begin{aligned} \sin^2\theta\frac{d\psi}{dt} &= \frac{Cn}{A}(\cos\theta-\cos\alpha)-\frac{C}{A}\int_0^t f(t)\,d\,.\cos\theta \\ \sin^2\theta\frac{d\psi^2}{dt^2}+\frac{d\theta^2}{dt^2} &= \frac{2Mg\gamma}{A}(\cos\theta-\cos\alpha) \end{aligned}\right\} \quad (5)$$

For the sake of simplicity suppose the initial position of the axis be horizontal, or $\alpha=90$ and the above become

$$\left.\begin{aligned} \sin^2\theta\frac{d\psi}{dt} &= \frac{Cn}{A}\cos\theta-\frac{C}{A}\int_0^t f(t)\,d\,.\cos\theta \\ \sin^2\theta\frac{d\psi^2}{dt}+\frac{d\theta^2}{dt^2} &= \frac{2Mg\gamma}{A}\cos\theta \end{aligned}\right\} \quad (6)$$

8.



If $aff'a'$ represents the cycloidal curve, and $aee'e''g'$ the curve in question, it will be observed that the angular velocity of the axis given by the 2nd equation (6) is the same for both, for equal values of θ, while the value of *the horizontal component* of that velocity, $\sin\theta\frac{d\psi}{dt}$, is less than for the cycloidal curve, by the term $\frac{C}{A\sin\theta}\int_0^t f(t)\,d\,.\cos\theta$.

As θ diminishes, $d\cos\theta$ is positive and this term is subtractive and hence for any point e or e' on the descending branch, $\frac{d\psi}{dt}$ is less than for the corresponding point f or f' of the cycloid, and the branch $aee'e''$ will be *behind* the branch aff', and will descend lower.

At e'' the term $\frac{C}{A\sin\theta}\int_0^t f(t)\,d\,.\cos\theta$, attains its *maximum*, for as the curve ascends, θ increases, and the increments of $\cos\theta$ become negative.

* When the retarding force is independent of the velocity, as in the case of friction, the $f(t)$ in the above expression is linear; when this force is dependent upon the velocity, as for the resistance of the air, $f(t)$ will, in general, be an infinite and diverging series in the powers of t; whether the force is due to either, or both combined, of these causes, the above expression for the velocity of rotation may however be used for the present purpose.

; as the values of t on this branch of the curve are nearly double those ual values of θ of the descending one, the integral $\int_{\theta_1}^{\theta} f(t)\,d.\cos\theta$ ecome zero at some point g', *before* θ has regained its initial value, ich point $\frac{d\psi}{dt}$ will be the same as for the corresponding point g of ycloid. Above the point g' the term $\frac{C}{A\sin\theta}\int_0 f(t)\,d.\cos\theta$ be- negative and (with its negative sign) becomes additive and there- ibove g' the values of $\frac{d\psi}{dt}$ are always *greater* than for corresponding of the cycloid. Hence the angular velocity of the axis can never ie zero and consequently the axis cannot rise to its initial elevation ›rm a cusp, but must make an inflexion and culminate at a, *below* itial elevation.

nmencing a second descent from a' with an *initial velocity*, the suc- ıg wave will be *flattened* (as shown in treating the subject of "initial ›ry velocities"), the second culmination a_2 will not (as a similar ›f reasoning to that just gone through for the first undulation proves) high as a_1: and *pari ratione*, each succeeding wave will be more ıed and extended than the preceding, until they soon virtually dis- r, and the curve becomes a descending helix.

er these undulations have disappeared, as the descent is only due s of rotary velocity (and consequently loss of *deflecting force*) ıred by $f(t)$, it is evident that the future character of the helix will ;ermined by this function.

fact, as the descending velocity $\frac{d\theta}{dt}$ is then very minute compared he horizontal velocity $\frac{d\psi}{dt}$, its square may be neglected in the 2nd , (6); and, equating the values of $\sin\theta\frac{d\psi}{dt}$ deduced from these quations, we shall have

$$\frac{C}{A}\int f(t)\,d.\cos\theta = \frac{Cn}{A}\cos\theta - \sin\theta\sqrt{\frac{2Mg\gamma}{A}\cos\theta}.$$

differentiating both members and making various reductions we get

$$\sqrt{\frac{Mg\gamma}{A}}\cdot\frac{3\sin^2\theta-2}{\sqrt{\sin\theta\sin 2\theta}} = \frac{C}{A}(n-f(t))$$

ıation which, *after the disappearance of the undulations*, gives the of θ in terms of t.

$f(t)$ increases θ diminishes in the first member, to the limit corre- ing to $\sin^2\theta = \frac{2}{3}$ which makes the numerator of the fraction in the ıember 0, and the denominator a maximum; showing, to that limit, ıtant descent of the axis, or a descending helix for the curve.

the values of $f(t)$ beyond $f(t) = n$ do not belong to the question, can be no farther descent below that value of θ which reduces the ıember to zero; or beyond $\sin^2\theta = \frac{2}{3}$.

At this elevation, as the *deflecting force* has vanished entirely with the rotary velocity, it is evident the elevation of the axis must be maintained by the *centrifugal force alone*, due to the gyratory velocity.

In fact, if we calculate directly the angle to which the axis must fall from a horizontal position, in order that the velocity generated shall be just sufficient, if deflected into horizontal gyration, to exert a centrifugal force adequate to maintain it, we shall find this same value, $\sin^2\theta = \frac{2}{3}$.*

In reality, the air resists gyration as well as rotation, and hence the descent will continue; but if a gyroscope could be placed in a *perfect vacuum*, and the slight friction at the point of support be entirely annulled, the axis would descend in a helix until it reached this limit, at which it would forever gyrate, though the rotation of the disk would soon by friction of the axle, entirely cease.

Art. XXXVII.—*Supplement to an Enumeration of North American Lichenes; Part first, containing brief diagnoses of New Species*; by Edward Tuckerman, A.M.

The following characters are intended to be as succinct as possible. It is hoped however that they will prove sufficient to indicate accurately the species described. Fuller descriptions, with especial reference to the details of fructification will be given in another place.

Alectoria Fremontii, sp. nova, thallo filamentoso pendulo ramosissimo implexo tereti-compresso lævigato fusco-nigrescente, ramis inferioribus hic illic incrassatis lacunoso-excavatis flexuosis tortuosisque, superioribus apice tenuissimis, ultimis simplicibus; apotheciis innato-sessilibus ex urceolato demum planis margine tenuissimo evanido discum viridi-flavo-pruinosum cingente. Evernia, Tuckerm. Exs. n. 52.

Hab. "Camp of Dec. 5, 6, 1854," (Sierra Nevada), "California, abundant on Pines," *Col. Fremont*, (com. Torrey!) "Hangs from the lower branches of all the coniferous trees of Northern California, and Southern Oregon. We saw it only about lat. 42° to 44°. Sometimes used by the Indians as a material for the manufacture of their rude mantles and

* If the solid of revolution is of dimensions so small that it may be considered concentrated in its centre of gravity, it would require, in the fall of its axis through angle $90°-\theta$, the velocity $\sqrt{2g\gamma\cos\theta}$; and this velocity, deflected into horizontal gyration in a circle whose radius is $\gamma\sin\theta$, would create a centrifugal force $2g\frac{\cos\theta}{\sin\theta}$, whose component normal to the axis of figure is $2g\frac{\cos^2\theta}{\sin\theta}$. Equating to this the opposing component of gravity $g\sin\theta$, we get $\sin^2\theta = \frac{2}{3}$, as in the text.

But this result is only true where the body has no sensible dimensions, though it is nearly so when, as in the ordinary forms of the gyroscope, the moment of inertia C is small compared with A. The above value of $\sin\theta$ is a *maximum* corresponding to $C=0$, and the limit at which the helix becomes horizontal becomes lower and lower as C is greater compared with A, the *general expression* being $\sin^2\theta = \frac{2(A-C)}{3A-2C}$.

That this result is not given by the analysis in the text is probably owing to its not being *strictly* true; for I have omitted the *forces* which retard the rotation of the disk and introduced their *effects on the angular velocity*, n, only.

costa," *J. S. Newberry*, Esq.! I follow Dr. Nylander in reëstablishing the genus Alectoria, Ach.

Ramalina tenuis, Fr. et Tuckerm. Mss., thallo cæspiticio cartilagineo rigido gracili plano-compresso lævigato viridi-glaucescente, ramis linearibus demum elongatis patentibus flexuosisque attenuatis, ultimis teretibus apicibus elongatis acutis; apotheciis majusculis marginalibus podicellatis disco subplano pallido-pruinoso marginem tenuem inflexum crenulatum demum excedente.

Hab. Trees; thickets of the Blanco, Texas, *Mr. C. Wright*! South Carolina, *H. W. Ravenel*, Esq.! Florida, *Dr. Blodgett!* Louisiana, *Dr. Hale!*

R. leptocarpha, sp. nova, thallo elongato membranaceo complanato lævigato glaucescente, ramis linearibus subsimplicibus reticulato-sublacunosis apice digitato-ramosis attenuatis acutis; apotheciis marginalibus tenuibus podicellatis margine incurvo persistente discum concavum albo-pruinosum cingente. R. Menziesii, Tuckerm. Synops., p. 12, (1848,) non Tayl. R. Scopulorum var. tenuissima, Hook. and Arn. in Beechey's Voy. p. 163? R. scopulorum? Menzies hb.!

Hab. Monterey, California, *Menzies!*

Roccella leucophæa, sp. nova, thallo coriaceo fragili ramosissimo intricato plano-compresso glabro fusco, ramis elongatis flexuosis attenuatis, ultimis teretibus filiformibus, passim concretis; apotheciis sessilibus plano-convexis margine thallode tenui integro discoque albo-velatis.

Hab. San Diego, California, on Obione canescens, *Dr. Parry*, (comm. Torrey!)

Cetraria chrysantha, sp. nova, thallo ochroleuco amplissimo cartilagineo foliaceo ruguloso reticulato-lacunoso, lobis expansis rotundatis crenatis marginibus adscendentibus crispis, subtus piceo lævigato nitido ad margines pallescente; apotheciis loborum marginibus antice adnatis scutelliformibus disco plano e sanguineo-rubro nigrescente margine tenui crenulato. C. glauca β. substraminea, Babingt. in litt.

Hab. Kotzebue's Sound, *Rev. C. Babington!* Rocks on an island of the Asiatic coast of Behring's straits, *Mr. Wright!* And fertile, on rocks of the coast of Japan, *Mr. Wright!* Distinct from C. glauca, as the perfect, fertile specimens abundantly show, and contrary to what is the case in that species, it is, so far as our specimens go, the broad-lobed, depressed state, which is fertile in this.

Erioderma Wrightii, sp. nova, thallo coriaceo crasso molli tomentoso viridi-fuscescente, lobis subangustatis profunde sinuato-divisis ambitu rotundatis crenatis, subtus e tomento denso fusco-nigricante spongioso-pannoso; apotheciis (centro affixis subpodicellatis) lobulis discoideis adnatis submarginalibus.

Hab. Trees on the top of Loma del Gato, Cuba, *Mr. Wright!* Growing with it is another very different species of this curious and little known genus, which is probably E. Chilense, *Mont.* The only other species is E. polycarpum, *Feé*, from the Isle of Bourbon, upon which the genus was founded. It is, I believe, new to the Flora of Cuba. The present species has quite the aspect of well-marked specimens of Peltigera rufescens, though there are not wanting resemblances, particularly on the under side, to Pannaria.

PARMELIA AURULENTA, sp. nova, thallo orbiculari submembranaceo lævigato ruguloso sorediis submarginatis hic illic exasperato glaucescente, subtus atro nigro-fibrilloso, strato medullari pallide flavo, laciniis imbricatis sinuato-lobatis retusis; apotheciis sparsis disco planiusculo badio margine inflexo subintegro.

Hab. Rocks, Harper's Ferry, Virginia. I have also specimens from trunks, South Carolina, *Mr. Ravenel!* and on rocks, Alabama, *Hon. T. M. Peters!* With much the look and lobation of that smooth state of P. saxatilis which was separated by Dr. Taylor as P. rugosa (Mackay Fl. Hib.) but differing remarkably in the color of the medullary layer. P. sulphurata, *Nees* and *Flot.*, which I have from Louisiana (*Dr. Hale!*) is distinguished similarly from P. perlata. P. stuppea, Tayl. (Lond. Journ. of Bot., vi, p. 175,) in which the medullary layer is dark-orange,—a not uncommon lichen in New England, and extending to the mountains of Georgia, (*Ravenel!*) is, in like manner, otherwise scarcely distinguishable from P. obscura.

P. TEXANA, sp. nova, thallo foliaceo imbricato membranaceo molliusculo lævigato rimoso pallide fuscescente, subtus nigro papillato, laciniis sublinearibus undulato-plicatis concretis convexis apice dilatatis sinuato-laciniatis lacero-crenatis, passim sorediiferis; apotheciis sparsis sessilibus badiis margine incurvo integro.

Hab. Thickets of the Blanco, Texas, *Mr. Wright!* Nearest to P. Borreri β. rudecta (P. rudecta, Ach.) but distinct. The genus Parmelia is here taken in the sense of Dr. Nylander, as including only the Imbricariæ of Fries. The Swedish lichenographer indicated in great part if he did not separate as genera, the divisions of the former writer, which are eminently natural.

PHYSCIA EUPLOCA, sp. nova, thallo cæspiticio molliusculo fragili orbiculari glabro fuscescente, laciniis tereti-compressis dichotomo-multifidis implexis appressis apice furcatis, subtus albo nudo; apotheciis sparsis (scutelliformibus) sessilibus disco saturate fusco opaco e plano demum convexo marginemque obtusum integrum excludente.

Hab. Shady rocks on the banks of creeks, Blanco hills, and elsewhere in Western Texas, *Mr. Wright!* The genus Physcia, Nyl., includes, beside the well-marked tribe of Fries, also Parm. parietina, and P. chrysopthalma, and the last section of Evernia, Fr., of which E. flavicans is, as yet, our only representative.

PSOROMA ASCOCISCANA, sp. nova, thallo incrustante e squamulis membranaceis rotundatis appressis concentrice rugosis demum coacervatis subcontiguo e viridi fuscescente, hypothallo nigro effuso; apotheciis adnatis disco opaco ruguloso rufo-fusco (nigricante) marginem thallodem crassum crenatum demum superante.

Hab. On trunks very common in the White Mountains, and I have found it in Massachusetts. Also on rocks, Vermont, *Mr. Frost!* New York, *Herb. Ravenel!*

PANNARIA HALEI, sp. nova, thallo e squamulis appressis crenatis imbricatis stuppeis glaucis in crustam subcontiguam dein coacervatis, hypothallo crassiusculo nigro marginante; apotheciis (biatorinis) superficialibus minusculis margine proprio tenuissimo discum pallidiorem convexum rufo-fuscum nigrescentem hypothecio crasso nigro impositum cingente.

Hab. Trunks, Louisiana, detected by the late *Dr. J. Hale*, to whom I have been indebted for several interesting collections. The genus Pannaria, Delis., as now understood, includes not only the tribe Amphiloma, Fr., of which our P. cronia and P. Russellii are examples,—but also Psoroma, Fr. (as reduced forms), of which our P. leucosticta is a common representative; excepting P. hypnorum, which, with Parm. sphinctrina, Mont., constitutes the genus Psoroma, *Nyl.*

SQUAMARIA FROSTII, sp. nova, thallo crustaceo adnato stellato-radioso lævigato glauco-eburneo, subtus nigro, laciniis subpalmato-multifidis convexis concretis passim sorediiferis, apicibus nigricantibus; apotheciis sessilibus, disco nigro, margine thallode tumido integerrimo.

Hab. Granitic rocks, Massachusetts and Maine, and southward to Harper's Ferry, Va. I have only seen it fertile from Vermont, *Mr. Frost!*

PLACODIUM EUGYRUM, sp. nova, thallo crustaceo adnato rimoso-areolato e viridi-luteo demum aurantio, ambitu radioso-plicato albo-pallescente; apotheciis sessilibus, disco plano aurantio-rubro, margine proprio tenui thallodeque crenulato mox evanescente.

Hab. Lime-rocks, Texas, *Mr. Wright!* Agreeing very much with P. circinatum, but of the lemon-colored series, and quite distinct.

LECANORA TEPHRASPIS, sp. nova, thallo crustaceo areolato-squamaceo areolis appressis crenulatis dein verrucoso-irregularibus fusco-cinerascente, subtus albo; apotheciis primitus emergentibus e rufo nigris demum prominulis planis margine proprio tenui thallodeque tumidulo cinctis.

Hab. Granitic rocks, Brattleborough, Vermont, *Rev. J. L. Russell* and *Mr. C. C. Frost!*

L. WRIGHTII, sp. nova, thallo e squamis discretis rotundatis lobatis crenatis mox subaggregatis lævigatis viridi-luteis (subaurantiis) marginibus elevatis pallidioribus, subtus pallidis; apotheciis sparsis emergentibus adnatis margine thallode crassiusculo rufo-fusco evanescente discum demum subgloboesum e rufo nigrum opacum cingente, intus albis.

Hab. On the earth, in denudated places; prairies and hills of the Blanco, Texas, *Mr. Wright!* Red river, Minnesota, *Mr. Lapham!* This and the next are perhaps the most interesting characteristic lichens of our western prairies, and the present appropriately bears the name of the botanist whose collections have done more than all else to illustrate the lichen-flora of our great southwestern territories.

L. CHONION, sp. nova, thallo e squamis discretis sessilibus rotundatis crassis subintegris margine depressis subrecurvis centro excavatis subinfundibuliformibus rufo-fuscis (sæpissime dealbatis) hypothallo nigro impositis; apotheciis marginalibus emergentibus sessilibus margine thallode crassiusculo subintegro fusco nitido demum evanescente discum convexum nigricantem opacum cingente, intus albis.

Hab. On the earth, prairies of the Blanco, Texas, *Mr. Wright!* And I have what seems to be the same from the Cape of Good Hope, *Zeyher* in herb. Sonder! It appears to me that this and the nearly allied Lecanora decipiens, Ach. Lichenogr. (Lecidea, Ach. Syn., Biatora, Fr.) together with the preceding species should be placed in Lecanora.

L. CHRYSOPS, sp. nova, thallo crustaceo e squamulis subaggregatis rotundato-difformibus peltatis lobatis angulato-repandisve nitidis læte flavis

(nunc albicantibus farinosis) apotheciis immersis disco nudo immarginato e rufo nigricante margine thallode tumidulo integerrimo cincto.

Hab. Lime-rocks, Organ mountains, Texas, *Mr. Wright!* Mt. Carmel, Mexico, *Wright!* Aiken, South Carolina, *Mr. Ravenel!* Appears to be distinct from L. Schleicheri.

L. DIPHASIA, sp. nova, thallo crustaceo effuso subcontiguo lævigato dein granuloso-verruculoso viridi-glaucescente; apotheciis adnatis planoconvexis margine proprio tenui thallodeque mox demisso crenulato discum rufo-fuscum viridi-pruinosum demum politum cingentibus.

Hab. Trunks, Texas, *Mr. Wright!*

L. CONIZA, sp. nova, thallo tartareo granuloso-farinoso glaucescente; apotheciis innatis, disco plano rubro-fusco, margine thallode elevato subintegro thallo albidiori.

Hab. Trunks, Brattleborough, *Mr. Frost!* Akin to L. subfusca, but quite different from any state of that species that I know.

L. SIDERITIS, sp. nova, thallo crustaceo crassiusculo areolato-subsquamaceo plumbeo-cinereo squamis subeffiguratis dein bullatis verrucæformibus, hypothallo nigro; apotheciis appressis disco immarginato fulvo-ferrugineo nigrescente nudo marginem thallodem tenuem incurvum demum excludente.

Hab. Rocks, Brattleborough, *Mr. Frost!* Nearest to P. cerina.

THELOTREMA SUBTILE, sp. nova, thallo crustaceo membranaceo effuso pallido; apotheciis depresso-subhemisphæricis subdifformibus dein scutelliformi-marginatis apertura ampla, excipulo interno discreto thallo albidiori laxo demum dilatato discum planum albo-velatum mox nigricantem cæsio-pruinosum margine albissimo lacero-crenulato cingente.

Hab. Trunks, Brattleborough, *Mr. Frost!* Virginia, E. T. South Carolina, *Mr. Ravenel!*

T. GRANULOSUM, sp. nova, thallo cartilagineo effuso lævigato verrucoso-granuloso glaucescente; apotheciis hemisphæricis granulatis apertura demum ampla irregulari submarginata, excipulo interno tenui evanescente discum depressum nigrum albo-pruinosum arcte cingente.

Hab. Trunks of cypress, Louisiana, with T. concretum, Fee, *Dr. J. Hale!*

T. RAVENELII, sp. nova, thallo crustaceo crasso coriaceo-cartilagineo effuso incrustante lævigato ruguloso rimoso fusco-cinerascente; apotheciis thallo inclusis, excipulo truncato-conico carneo margine tenui albo cum crusta mox concrescente evanido aperturam punctiformem orbicularem cingente discumque concaviusculum nigrescentem fovente. Sporæ ellipsoideæ fuscæ.

Hab. Trunks of maple, hickory and other trees, Santee Canal, S. C. *Mr. Ravenel!* Alabama, *Mr. Peters!* Mississippi, *Dr. Veitch!* Louisiana, *Dr. Hale!* The exciple resembling that of Endocarpon, except that the neck is wanting, but the disk entirely that of Thelotrema, with which its spores also accord. It has the habit of T. concretum, *Feé.*

PILOPHORON, genus novum. Apothecia terminalia immarginata cephaloidea, disco hypothecio crasso atro imposito, solida, strato medullari recepta. Sporæ ellipsoideæ hyalinæ. Podetia verticalia caulescentia subsimplicia cartilaginea subfistulosa e thallo horizontali granuloso-subsqua-

maceo adnato surgentia eoque vestita. (Stereocaulon § Pilophoron, Tuckerm. Synops. p. 46. Cenomyce, Ach., Floerk., &c. pro parte.)

P. FIBULA, Tuckerm. (sub Stereocaul. l. c.)

Hab. Moist rocks along streams in the White Mountains.

P. POLYCARPUM, sp. nova, thallo granulato-squamaceo e viridi glauco, podetia plurima cæspitoso-conjuncta superne digitato fastigiata corymbiformia dura subcompressa intus araneo-subfistulosa granulis crustæ vestita demum denudata e rufo nigrescentia proferente; apotheciis terminalibus depresso-globosis immarginatis demum inflatis atris.

Hab. "Hills, growing upon spots of bare ground," upon pebbles, &c., in an island on the Asiatic shore of Behring's Straits, *Mr. Wright!*

P. ACICULARE, Tuckerm. (sub Stereocaul. l. c.)

Hab. "On stones and dead trees, frequent on the west coast of North America, 1787–1788," *Menzies! Douglas* in Herb. Hook.! *Scouler* in Herb. Hook.! Rocky Mountains, Herb. Hook.! With the whole aspect of Cladonia, these lichens possess the thallus of Stereocaulon, and almost the apothecia of Lecidea. The exact limitation of the species must however be left for further investigation. A small Lecidea is parasitic on the podetia of some specimens, and appears not unlike L. parasitica, Floerk.

CLADONIA SANTENSIS, sp. nova, thallo cæspiticio, squamulis foliaceis laciniatis adscendentibus podetiisque simplicibus superne scyphiformi-dilatatis fastigiato-subramosis granulosis glaucis; apotheciis minusculis conglomeratis rufis.

Hab. On the earth, at the base of trees, Santee canal, S. C., *Mr. Ravenel!* Akin to C. papillaria and C. turgida, but distinct.

C. CAROLINIANA, Schwein. herb. (sub Cenomyce) thallo crustaceo evanido, podetiis aggregatis bullato-ventricosis subsimplicibus superne obconico-dilatatis sublacunosis fragilibus glabris viridi-stramineis, axillis subintegris, ramis obconicis turgidis fastigiatis subdichotomis ramulo altero obsolescente, ramulis in papillas elongatas inflatas gibbosas abeuntibus, apicibus obtusis dentatis; apotheciis e carneolo fuscescentibus.

Hab. On the earth, Salem, N. Carolina, *Schweinitz hb.!* Mountains of Georgia and Tennessee, *Mr. Ravenel!* This lichen is extraordinarily marked, and is unknown to the European Flora. It is still difficult to indicate satisfactory characters to distinguish it from extreme, or at least possible states of C. uncialis var. turgescens, Schær., though I believe the two to be quite distinct plants.

C. PULCHELLA, Schwein. herb., thallo cæspiticio squamuloso podetiisque cylindricis gracilibus membranaceo-corticatis squamuloso-exasperatis dein granuloso-pulverulentis e viridi glaucis, scyphis obsoletis, apotheciis (conglomeratis) symphycarpæis.

Hab. Salem, North Carolina, *Schweinitz hb.!* On rotten logs, S. Carolina, *Mr. Ravenel!* Georgia, *Ravenel!* Alabama, *Mr. Beaumont!* Florida, *Dr. Chapman!* Louisiana, *Dr. Hale!* Texas, *Mr. Wright!* The squamulose podetia resemble those of C. bellidiflora in miniature; and the powdery ones are sometimes almost undistinguishable from those of C. macilenta. There are somewhat similar small states of C. Floerkiana.

C. CETRARIOIDES, Schwein. herb., podetiis crassiusculis subdichotomo-fruticulosis cartilagineo-corticatis reticulato-rugulosis glabris viridi-fusces-

centibus, axillis infundibuliformibus oblique dilacerato-extensis margine radiato-proliferis radiis lateralibus abbreviatis terminali elongata compressa, apice cristato-denticulatis; apotheciis coccineis.

Hab. North Carolina, *Schweinitz herb.!* The description is made from the original specimen, which is the only one I have seen. The habit is of some states of C. furcata var. crispata. It is likely that the full development of the lichen is not here indicated.

C. LEPORINA, Fr. herb., thallo squamuloso evanido podetiisque adscendentibus inflatis subturbinatis margine repetito-proliferis ramosisque demum subtrichotome ramosissimis gracilibus erectis fruticulosis rugulosis e sulphureo-pallescentibus, axillis subperforatis, apicibus radiato-dentatis, fertilibus cymosis; apotheciis coccineis.

Hab. Salem, North Carolina, *Schweinitz* in herb. Fries! *Rev. Dr. Curtis!* South Carolina (pine barrens) and Georgia, *Mr. Ravenel!* Florida, *Herb. Russell!* Alabama, *Mr. Peters!* Texas, *Mr. Wright.* Perfectly analogous to C. rangiferina.

C. CRISTATELLA, sp. nova, thallo evanido, podetiis cylindricis gracilibus superne scyphiformi-subdilatatis cristato-radiatis radiis repetito-proliferis, fertilibus cymosis, verruculosis glauco-viridibus, axillis perviis; apotheciis coccineis.

Hab. Base of the White Mountains, found by the late *Mr. Oakes.* I can compare it only with the last, with which it may yet be found also to agree in becoming at length fruticulose.

COCCOCARPIA MICHENERI, sp. nova. Biatora, Tuckerm. in Darlingt. Fl. Cest. edit. tert. p. 446.

Hab. At the base of trunks of oak, Chester Co., Pennsylvania, *Dr. Michener!* Penn Yan, N. Y., *Dr. Sartwell!* South Carolina, *Mr. Ravenel!* Alabama, *Mr. Beaumont!* Mississippi, *Dr. Veitch!* Louisiana, *Dr. Hale!* Texas, *Mr. Wright!* This genus, indicated by Persoon (in Gaudich. Uran. Bot., p. 226) has been further illustrated by Dr. Montagne (Ann. Sci. Nat., Aug. 1841, p. 83), and there is no doubt of the naturalness of its separation from Biatora, and I incline also, with Dr. Nylander (Nouv. Classif. Lich. in Bot. Not. n. 9, 10, 1855) to place it among the Parmelieæ, and next to Pannaria. Our species extends further northward than any before known, the genus being a tropical one.

LECIDEA ELIZÆ, sp. nova, thallo crustaceo effuso e granulis minutis lætevirentibus demum glaucis; apotheciis appressis plano-convexis disco nudo sanguineo-rubro nigricante margine tenuissimo erecto nigro cincto, intus nigris.

Hab. Bark of pines in Sussex, Virginia. I have also received it from Vermont, *Mr. Frost!* It is very distinct from L. fuscescens, Sommerf. (Nyl. Prodr. Gall., p. 117, Lich. Paris n. 133.)

L. SANTENSIS, sp. nova, thallo effuso e squamulis crenatis mox tereti-corallinis ramosis crustaceo-coacervatis glauco-viridibus, hypothallo albo; apotheciis subapplanatis margine obtuso evanescente discum demum convexum nitidum rubro-fuscum margine pallidiorem nigricantem (decolorantem, subtus nunc albo-fibrillosum) cingente, demum conglomeratis.

Hab. Trunks, on the Santee Canal, S. C., *Mr. Ravenel!* Georgia, *Mr. Ravenel!* Alabama, *Mr. Beaumont!* Mississippi, *Dr. Veitch!*

Louisiana, *Dr. Hale!* Nearest to L. vernalis and L. sanguineoatra, but apparently quite distinct.

L. VERNICOMA, sp. nova, thallo crustaceo effuso subtartareo e granulis minutis demum in crustam subrimosam conglomeratis viridi-stramineis; apotheciis minusculis appressis margine tenui erecto evanescente discum subplanum cingente, nigris.

Hab. Granitic rocks, Essex, Massachusetts, found by the late *Mr. Oakes!* Chester Co., Pa., *Dr. Michener!*

L. LEPIDASTRA, sp. nova, thallo crustaceo effuso, areolis primitus discretis subsquamulosis crenatis glaucescentibus; apotheciis cupularibus e strato corticali oriundis sessilibus disco opaco nudo plano margine persistente tenui aterrimo cincto, demum confluentibus.

Hab. Granitic rocks, Brattleborough, Mr. Frost!

OPEGRAPHA MYRIOCARPA, sp. nova, thallo crustaceo effuso e granulis minutis subtartareis coacervatis fusco-cinerascentibus; apotheciis minutissimis rotundato-sublirelliformibus superficialibus atris, disco plano-concavo margine turgido elevato inflexo cincto.

Hab. On yellow birch and other trees, in the White Mountains, and in Western Massachusetts. Our smallest species, and remarkable for its well-developed crust. The apothecia often pseudo-lecideine, but the spores accord with those of Opegrapha.

GLYPHIS ACHARIANA, sp. nova, thallo crustaceo effuso cerato lævigato viridi-fuscescente; stromate elevato plano-convexiusculo rotundo-difformi demum deliquescente cinereo-glauco; apotheciis variantibus e subsolitariis rotundato-subangulosis demum confertis dendriticis vel radiatim ramosis confluentibusque medusuliformibus fuscis plano-concavis. G. favulosa, Ach. et G. cicatricosa, Ach.

Hab. Trunks, Santee canal, S. C., *Mr. Ravenel!* North Carolina, *Dr. Curtis!* Alabama, *Mr. Peters!* Mississippi, *Dr. Veitch!* Louisiana, *Dr. Hale!* Also Portugal, *Dr. Welwitsch!* Guyana, *Montagne!* Brazil, *Meissner!* Hong Kong, China, *Mr. Wright!* Eschweiler (Lich. Bras., p. 166–7) appears to have confused the Acharian characters of the two species. Our lichen is G. favulosa, *Ach.*, but G. cicatricosa, *Ach.* is certainly not to be distinguished from it, and if I understand our American lichen aright it has a development not indicated by Acharius.

TRYPETHELIUM CAROLINIANUM, sp. nova, thallo crustaceo cerato lævigato e viridi fuscescente, verrucis depresso-subhemisphæricis confluentibus difformibus subanastomosantibusque saturate fuscis nigrescentibus, stromate flavo, peritheciis ovoideis tenuibus atris, ostiolis papillatis nigris.

Hab. Trunks, Santee canal, S. C., *Mr. Ravenel!* Hillsborough, N. C., *Dr. Curtis!* Louisiana, *Dr. Hale!*

PYRENASTRUM RAVENELII, sp. nova, thallo crustaceo membranaceo tenui subcerato fuscescente, peritheciorum verrucis conoideo-elevatis thallo primitus vestitis demum denudatis, peritheciis lageniformibus 4—8 convergentibus (nunquam confluentibus) ostiolis pallidis acutis distinctis.

Hab. Trunks, Santee canal, S. C., *Mr. Ravenel!* My materials are too imperfect to enable me to complete the description of this fine species, which appears to be rare.

P. GEMMEUM, sp. nova, thallo crustaceo effuso subcartilagineo cerato lævigato pallido-viridi-fuscescente; peritheciis emergenti-prominentibus

lageniformibus ostiolis obliquis incrassatis thallo coronatis, pluribus (—10) plerumque in verrucas astroideas depresso-subconicas ostiolis convergentibus aggregatis, vel demum in perithecium compositum, ostiolis connatis, confluentibus, ascis clavatis sporas 6—8 oblongo-ellipticas includentibus.

Hab. Trunks, Texas, *Mr. Wright!* Santee Canal, S. C., *Mr. Ravenel!*

GYROSTOMUM CURTISII, sp. nova, thallo crustaceo tenui membranaceo rimoso cinerascente, linea nigra limitato; apotheciis depressis excipulo nigro subnitido nucleum disciformem mox deliquescentem superne nigrescentem obtuse marginante.

Hab. Trunks, North Carolina, *Rev. Dr. Curtis!*

CORRESPONDENCE.

1. *Correspondence of J. Nicklès, dated Paris, January* 8, 1858.*

Biographical notice of Thenard.—We have been slow in fulfilling our promise respecting a notice of this illustrious chemist, because of the difficulty of procuring accurate details of his life. His family have kept silent; and nothing has been published except a pamphlet by one of his old assistants, Mr. Le Canu, now professor at the school of Pharmacy of Paris. From this pamphlet we learn that Thenard was born on the 4th of May, 1777, at the small village of Louptière, in the department of Aube, where his parents were farmers. His first chemical publication dates from the year 1799, and treats of the oxyds of antimony; it was the subject of a commendatory report by Guyton Morveau, which was very encouraging to the young chemist. The principal works of Thenard are well known:—his discovery of oxygenized water; that also of sebacic acid; his physico-chemical researches carried on and published in connection with Gay Lussac. And besides the services rendered by him to science, through his discoveries, and his instruction in the Faculty of Sciences, Polytechnic School and College of France, he contributed much to the arts by the discovery of the *Thenard blue*, a compound of phosphate of cobalt and alumina used by painters; also by a process for purifying the oil of Colza (by means of sulphuric acid); a process for the manufacture of white lead (by means of the tribasic acetate of lead and carbonic acid). Thenard was 30 years President of the "Société d'Encouragement," and shortly before his death, he founded the Society for the assistance of the friends of science, of which we have spoken in a former number.

Death of Peclet.—The celebrated author of the "Traité de la Chaleur appliquée à l'industrie et aux arts," the "Traité de l'Eclairage," etc., died at Paris on the 7th of December last, after some days of sickness, aged 65 years, just as he was about resuming at the Central School of Arts and Trades his course on applied physics. He was one of the founders of this celebrated establishment which has furnished engineers for almost all Europe; the others being Dumas and Theodore Olivier who died about two years since, and of whom we have given a short biographical

* This letter was received too late for our last number. Some parts of it are omitted, as the subjects have already been brought out in the Journal.

notice. This school began in 1829, but encountered difficulties from political events, and in 1832 from the cholera which dispersed the students. For twenty years it has had great prosperity. It is about to be purchased by the State and changed into a government school.

Submarine railroad between France and England.—The gigantic project of a submarine railroad between France and England has for two years engaged the attention of the French government. Many, in times past, have projected such a connection of Britain with the continent; but their projects were without a basis of observation. This is not so with the plan now under consideration, which has already excited much interest in the public at large. The author is a French engineer, Thomas de Gamond. He has not put forward his scheme except after a persevering study, as complete as the case admits of, of the region across which the tunnel is projected, and an examination into the causes which have concurred to the formation and preservation of the Calais straits.

Mr. Gamond has been occupied with the subject directly or indirectly since 1833. He has studied out three methods and six lines; and his results are presented with full details in the memoir which he has published entitled "Etude pour l'avant-projét d'un tunnel sous-marin entre l'Angleterre et la France." He has also published his geological and hydrographical researches made in this connection, and also the observations made by the official commission consisting of the General Council of Mines, over which Elie de Beaumont presides, and the General Council of the Department of Roads and Bridges. He considers the various objections; and to the general remark that it is impracticable, he says that there is no part of it which has not its equivalent actually accomplished in some of the works completed during the past 30 years.* The following extracts from the memoir of Mr. Gamond, will enable the reader to judge respecting it.

(1.) *The Region to be traversed.*—On the French side, in the vicinity of the Calais straits, the stratified rocks are of the Jurassic age. They dip under the straits, and to a great extent are there covered by Cretaceous deposits 200 meters thick. The inclination is 7 feet in 1000. In Oxfordshire the dip is 3 feet in 1000. This difference is not supposed to be owing to a submarine fault, as at first thought, but to a slight curve in the strata beneath the straits. Thus about two-fifths of the Calais straits are formed of oolitic limestones, compact sandstone of the Portland epoch and the greensand of the Cretaceous. The rest of the material consists of clay strata of three ages—the Oxford clay, the Kimmeridge clay 150 meters thick, and the Weald clay. The presence of these clay beds is considered very favorable.

(2.) *Line of the tunnel.*—The line leaves the Continent under Cape Grinez near Calais and takes a course towards Eastware point between Downs and Folkestone, passing by the sandbank "le Varne," where the maritime station for the tunnel will be established. Here the train will come out to daylight. The area of the station house will be the bottom area of a

* As this project is one of those that require the coöperation of two governments, it has been already submitted to the English nation. Lord Palmerston appears favorably disposed, if we may judge from the good word which he spoke on that occasion. "The project will succeed, for it is well regarded, and has in its favor all the ladies of England."

vast enclosure constructed upon the platform of an artificial island made upon the top of the bank of Varne. To this platform a covered wharf will be annexed. It will contain within, as planned, an elliptical court, the longer diameter (or that in the direction of the trains) 200 meters, and the shorter, 100 meters in length. The cars will come up to it by a gentle declivity, and here will be along side of shipping. The track will describe a curve, the grade of which will be about 5 feet in 1000, a very low grade compared with what is common on railroads.

Infiltration of water either fresh or salt is to be expected; but happily the slope of the strata is exceedingly gentle, and the waters in their capillary infiltration will have to make a descent of 2000 to 4000 meters—so that the direct pressure of the sea will not be felt, and it will be like any ordinary case of freshwater infiltration.

(3.) *Tunneling.*—If the execution of the project is undertaken, Mr. Gamond will commence at several points at once by means of a series of artificial islands made of a conglomerate of rocks and clay, through which he will sink 13 shafts. Upon these 13 islands, workshops for excavation will be built, and observatories for the alignment of the sections. By means of this subdivision of the whole into 14 sections, 28 corps of workmen can be employed at once, and each upon a length not exceeding 1500 meters, so that the whole may be finished in 6 years, as follows:—the 1st year, the construction of the 13 islands and sinking of the shafts; 2d year, piercing the five "sections directrices;" 3d, 4th, 5th, and 6th years, making the remaining nine sections. After this is accomplished, the artificial islands are to be removed by powder, that they may not stand as obstructions in the straits.

The tunnel will be a perfect vaulted cylinder, offering in its superior arc an open section nine meters across and seven meters high.

The cost of construction is estimated at 112,000,000 francs—or at the ratio for the whole of 3400 francs a meter. The total expense, to its going into complete activity, will probably reach 170 millions of francs. We will keep our readers informed of the progress of matters relating to this great question.

Perforation of lead by insects.—At one of the late sessions of the Academy of Sciences, a lead ball from the Crimea, found in a Russian cartouche, was examined with much interest, which had been perforated through and through by an insect. The fact was at first thought to be new: this was soon corrected by the mention of several similar cases by Mr. Dumeril. The insect that perforated the lead is a Hymenopter of the order Urocera (Geoffroy).

Reaumur describes an insect of this kind. The female of the species carries under its venter a borer armed on each side with eight obliquely reversed teeth. Dumeril holds that the perforation is made, not for food, but only to open a passage for itself; and from among the observations published on this subject, he cited a fact by Mr. DuBoys of Limoges, who in 1843 saw some stereotype plates that had been riddled with holes by a species of *Bostrichus*, Geoffroy, (B. capucinus, the Apata capucina of Fabricius,) two individuals of which he had found in the perfect state. Moreover DuBoys made an experiment demonstrating that these and other insects are capable of boring through lead. He put in a glass jar two

ividuals of the species Callidium sanguineum, separated by a plate of l; and after some days he found the plate perforated and the two cts together. Afterwards he assured himself by a chemical analysis t the lead was not taken into their bodies.

Correspondence of J. Nicklès, dated, Feb. 28, 1858.

lcademy of Sciences.—Distribution of Prizes.—The annual session, ch usually begins with the announcement of prizes, and closes with ılogy upon some distinguished deceased man of science, was held on 8th of February last. The subject of the eulogy was the celebrated gendie, whose eminent qualities were combined with great defects. ras by Flourens the Perpetual Secretary.

'he great *prize in Physical Science* was divided between Mr. Lieberın, Dissector at the Amphitheatre of Anatomy at Berlin, and MM. pazède and Lachmann of Geneva. The subject was as follows:—*A rous and systematic investigation of the metamorphosis and reproduc- of the Infusoria properly so called (Polygastrics* of Ehrenberg). ıile rendering justice to the merits of these researches, the Academy the report of Mr. Quatrefages, added that the question it had proed was still not wholly resolved. "The great difficulties and extent the subject, are sufficient reason for the fact that while numerous ups of Infusoria have been studied with care, this is not true of all; l it is especially to be regretted that the Keronidæ and Plœsconidæ 'e not yet been taken up, families which include some of the highest ns of the Infusoria. For it has been well demonstrated by a young uralist, unfortunately removed from science, Jules Haime, that these ups consist of actually adult species, whose larves have been taken for er distinct species."

Che *prize in Experimental Physiology* has been given to M. Auguste ller for his discovery of the metamorphosis of the river Lamprey (Pteıyzon Planeri, Bl.). Mr. Muller has demonstrated that the Ammocetus, ıerto regarded as a distinct species, is only a larval state of Cyclosto-, as the tadpole is the larve of a Batrachian, thus opening to science only a new fact but a new field of investigation,—by proving metorphosis to exist in a class where it has not before been suspected, and wing the importance of examining whether other species of the class form to the law.

Che Academy decreed an "honorable mention" to Dr. Phillipeaux for work upon "The removal of the Suprarenal Capsules," a work in ich the author shows that these capsules may be removed from an mal, one after the other or simultaneously, without disturbing at all regular action of the essential animal functions. Dr. P. operated albino rats.

Another "honorable mention" was accorded to M. Lespès, for his meir on the Spermatophora of certain Orthoptera and on the organiza-ı of the Termites.

A prize of 1200 francs was given to M. Brown-Sequard for his labori- researches on the properties of arterial and venous blood. This 'siologist has established by experiment that the transfusion, which ıerto has been believed to be practicable only between animals of the

same class, may, under certain precautions, take place between those of different classes, and particularly from a bird to a mammal. The author has also studied the property, which the arterial blood has, of restoring, upon repeated injection, the irritability and contractility in parts that have lost them, after having been separated a certain time from the body. He has observed these two properties return to members of a dog, when they seemed extinct,—the members having already become rigid.

Among the prizes relating to the arts hurtful to health, there is one for the "Torrefacteur mécanique" of Eugene Rolland of Strasburg, which is used for the desiccation and torrefaction of tobacco, in the manufactories of Strasburg, Lyons and Paris. The torrefaction is made to take place without the usual escape of vapors, dust or essential oils, and the number of workmen is reduced in the ratio of four to one. The material is exposed to a temperature regulated by a thermo-regulator, between limits not exceeding five or six degrees. The desiccation is perfectly uniform and is attended with almost no loss from burnt fragments or powder. The invention was honored with a great medal at the "Universal Exposition" in 1855.

The following are some facts respecting the present condition of the manufacture of tobacco at Paris. In a day of ten hours, the torrefier is fed with 7000 kilograms of moist tobacco, which, on being removed, at thé temperature 70° C., is found to have lost 13 per cent of its weight; it loses $1\frac{1}{2}$ p. c. more during the cooling to the ordinary temperature. In this operation, there are consumed 300 k. of coke from the gas furnaces. Hence about 1000 k. of water and other matters are evaporated by the combustion of 300 k. of coke, or $3\frac{1}{3}$ k. of water for 1 k. of coke. But this does not exhibit all the value of the apparatus. For it is employed also for drying cut leaves for cigars which lose 40 p. c. of water. In the old process, more than 3 k. of steam were used in driving off 1 k. of water.

Prize in Chemistry.—The Academy has at last awarded a prize in chemistry. And now, when ready to recompense works of this kind, it is due to the liberality of one foreign to the Academy, Dr. Jecker, who has given a sum with the stipulation that the annual income, amounting to 12,000 francs, should be given to the *author of the best work on Organic Chemistry.* The Jecker prize was divided between two chemists. Although founded several years since, this is the first time it has been awarded. The sum of 12,000 francs might once have been very useful to the two laureats; but now Laurent is dead, as well as Gerhardt; and the prize is given them as an homage to their memory, and also to escape the pressing solicitations of some living chemists.

Prize in Physics.—Induction Apparatus.—It is owing to a foundation also that this prize has been awarded. The founder, Mr. de Trémont, contributes annually a sum of 1000 francs to "aid some savant without means in the expenses of experiments from which there is reason to expect new discoveries or improvements in science and the industrial arts." Many names of persons in different departments were brought before the Academy, and among them, they chose unanimously that of Mr. Ruhmkorff, whose works are well known and appreciated in and out of France. His reputation began with the construction of the Melloni apparatus for measuring radiant heat; but he is especially distinguished for his dis-

magnetic apparatus and his induction machine. The last machine, with two of Bunsen's pairs, affords, in the air, sparks about two centimeters (nearly eight inches) long, and in a vacuum, waves of light comparable to those of a powerful electric machine, although having many distinguishing characteristics. By a recent improvement, Mr. Ruhmkorff has greatly increased its power; and with 25 of Bunsen's pairs, he produces sparks 30 centimetres long; and for certain effects it is superior to a friction battery.

Prize in Geology.—This prize, the subject of which is *The Metamorphism of rocks*, has not been awarded. The Academy continues the subject, under the following terms. The authors should review the history of all attempts, since the close of the last century, to explain, on the ground of an original sedimentary deposition of the beds and a subsequent alteration of greater or less extent, the present condition of various rocks. They should review the physical and chemical theories proposed, and make known the one they adopt. The Academy would have them mention the experiments they have made to verify and extend the theory of metamorphic phenomena. The prize is a medal of gold, of 3000 francs.

Another prize of the same value will be awarded on the following question—"To determine experimentally what influence insects may exert on the diseases of plants;" and another on the subject "The mode of fecundation of eggs and the structure of organs of generation in the principal natural groups of Polyps and Acalephs." *(To be concluded.)*

2. *On the origin of Feldspars and on some points of Chemical Lithology;* by T. Sterry Hunt, of the Geological Survey of Canada, (in a letter to J. D. Dana).—In a communication to the Royal Society of London, read on the 7th of May, 1857,* I showed that solutions of alkaline carbonates may give rise to the formation of silicates of lime, magnesia, and protoxyd of iron, when heated to 212° F. with mixtures of the carbonates of these bases with quartz, a silicate of the alkali being first formed, and then decomposed by the earthy carbonates. Shortly after, in my report of the Geological Survey for 1856, I suggested that the alkaline silicates might combine with silicate of alumina to form those feldspathic and micaceous minerals which are so generally associated with the silicates of protoxyd bases; I further suggested that these minerals might be crystallized by the aid of heated alkaline solutions under pressure, and I thus endeavored to explain the development of crystals of feldspar and mica in sedimentary rocks, even where the organic remains are still preserved.

While arranging an apparatus in which I proposed to heat under pressure a solution of carbonate of potash with silica and kaolin, in the hope of obtaining a double silicate of alumina and potash, Mr. Daubrée announced to the French Academy of Sciences (*Comptes Rendus*, Nov. 16, 1857) that he had succeeded in obtaining crystalline feldspar, mixed with crystals of quartz, by heating during a month, a mixture of kaolin and silicate of potash to 400° C. He has moreover shown that feldspars and pyroxenes are very stable in presence of heated alkaline solutions, and that crystallized diopside and wollastonite are formed when artificial

* See this Journal, vol. xxv, p. 287, also vol. xxiii, p. 437.

glasses, containing lime and iron, are heated in the same way to 400° C. in the presence of a small amount of water. The alkaline silicate which separates from the decomposition of the glass is resolved into quartz, which forms regular crystals, and a soluble silicate having the formula SiO, KO.

These results of Mr. Daubrée serve in the most remarkable manner to confirm my theory of the normal metamorphism of sedimentary rocks at temperatures below ignition, by the intervention of solutions of alkaline silicates, which convert mixtures of quartz and earthy carbonates into the corresponding silicates, and clays into feldspars and mica, the intervention of alumina sometimes generating chlorite, epidote and garnet.

Daubrée remarks that glass when thus heated in presence of water swells up, indicating a softening and a plasticity of the mass, and he observes that his experiments enable us to understand the part which water may have played in the formation of the igneous rocks. His observations go far to support the views of Poulett Scrope and Scheerer, who maintain the aqueo-igneous fusion of granites and lavas, a theory which is farther sustained by the curious microscopical investigations of Mr. Sorby lately presented to the Geological Society of London.*

Sir John F. W. Herschel many years since put forward a theory of volcanos, in which he suggested that all volcanic and plutonic rocks were no other than sedimentary deposits, melted down with their included water. I have endeavored, in a paper read on the 6th of March before the Canadian Institute at Toronto, to show that this theory is the one most in accordance with the present state of chemical and geological science. We are probably acquainted with no rocks not of aqueous origin, and the intrusive form so often assumed by granites, syenites, dolerites, and even by ophiolites and limestones is not essential but accidental.

In my report for 1856, p. 485, I have insisted that the separation of oxyd of iron from certain strata, and its accumulation in others, is to be ascribed to the reducing and solvent action of organic matters. This is exemplified in the fire-clays and iron-stones of the coal formation, as well as in the series of the Hudson river group described in my Report, in the fire-clays and greensands of the cretaceous formation of New Jersey, and many other instances. It is by the alteration of such materials that the white feldspathic rocks of metamorphic regions have been formed, and it is probable that beds of iron ore always owe their origin to the intervention of organic matters, so that the presence of such ores, not less than that of graphite, points to the existence of organic life even during the Laurentian or so-called Azoic period.

The waters which dissolve out the oxyd of iron from sediments, also remove lime and magnesia, especially if these bases are present in the condition of carbonates, and hence these bases, especially the latter and more soluble, are generally absent from white clays and feldspar rocks. If however the quantity of lime be large as compared with the iron, this may be removed while a portion of lime remains; if on the other hand, the reducing agency of organic matters be excluded, carbonated waters may remove lime and magnesia, leaving the peroxyd of iron behind.

* Philos. Mag., vol. xv, p. 152.

From my own and others analyses of the alkaline mineral waters, derived from argillaceous rocks, it will be seen that the salts of potash in these waters are generally in very small quantity when compared with the salts of soda, although potash predominates in argillaceous shales and clay-slates. The soda is therefore gradually removed from these rocks by infiltrating waters, while the potash remains behind, and hence it happens that when these rocks, from which the lime, magnesia and oxyd of iron have been dissolved, are subjected to the process of metamorphism, potash-feldspar will predominate, together with quartz from the deficiency of bases, while silicates like cyanite and staurotide may be formed from the excess of alumina. The more quartzose sediments, other things being equal, are most permeable to water, and hence will have lost greater proportions of soda, lime, magnesia, etc. than the finer clays and marls.

I have here indicated a few principles which must I think for the future serve as guides in investigating the chemistry of rocks, whether stratified or plutonic. You will see how the action of these laws necessarily divides the silico-aluminous sedimentary rocks into the two great classes recognized by Bunsen and Durocher in their investigations of igneous rocks. In the trachytic and granitic division the silica and potash predominate, while the soda, lime, magnesia and iron are present only in small quantities, while in the pyroxenic rocks silica and potash are less abundant, and soda-feldspars with more or less basic silicates of lime, magnesia and oxyd of iron predominate.

Montreal, March 10, 1858.

3. *On Euphotide and Saussurite*; by T. Sterry Hunt. (In a letter to J. D. Dana, dated Montreal, March 16, 1858.)—Through the kindness of Prof. Arnold Guyot I have had an opportunity of examining a collection of the euphotides of Mt. Rose, and of satisfying myself as to the nature of the true *Saussurite* (the *jade* of de Saussure), which is a white mineral forming with grass-green smaragdite, the *Euphotide jadien* of Brongniart. It appears to be a compact epidote or zoisite, having, as de Saussure long since determined, the hardness of quartz, and a density of 3·3—3·4. My own analysis of a fragment from Mt. Rose, with a density of 3·36, gives the composition of a lime-alumina epidote, with a little soda. The analyses of Boulanger of the saussurites of Mt. Genèvre and Orezza, lead to the same conclusion.

Saussurite is then nearly related to the massive white garnet from the Green Mts. in Canada, which, mixed with serpentine and with amphibole gives rise to varieties of rocks which I have described in my report of the Geological Survey of Canada for 1856, as resembling certain euphotides. The smaragdite of Mt. Rose is a vanadiferous diallage, approaching in composition the variety from near Genoa, analyzed by Schafhaütl. I may here remark that I have lately detected vanadium, with chromic iron, and oxyd of nickel in a serpentine from Gaspé.

The true euphotide is then distinct from those diallagic dolerites with which it has been confounded by Delesse, Coquand, and most modern lithologists. I propose soon to send you my results in a detailed form, with a sketch of the history of euphotide.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the equivalents of certain Metals.*—Von Hauer has determined the equivalents of cadmium and manganese by heating known quantities of the sulphates in a current of sulphid of hydrogen and weighing the resulting sulphids. The author found 56 as the equivalent of cadmium by nine experiments agreeing as closely as could be expected, the differences being in the second decimal place only. The equivalent of manganese was found by a precisely similar process to be 27·49 as a mean of nine experiments. Berzelius found for this metal the numbers 27·6 and 27·61, his results being corrected for the new equivalents of silver and chlorine. Von Hauer adopts 27·5 as the true equivalent. [This number differs remarkably from that determined by Dumas who found 26.] The same chemist has also determined the equivalent of tellurium by determining the quantity of bromine contained in the crystallized bromid of tellurium and potassium $KBr+TeBr_2$. The mean of five experiments gave 64·03 which corresponds with the new equivalent of Dumas.

Schneider has determined the equivalents of cobalt and nickel by analyses of their oxalates, the relative quantities of carbon and metal being found, the former by the usual methods of organic analysis, the latter by oxydation and subsequent reduction in a current of hydrogen. In this manner the equivalent of cobalt was found to be 30 and that of nickel 29, each a mean of four analyses.—*Von Hauer in Chemisches Central Blatt, Nos.* 56, 57, 1857. *Schneider in Pogg. Ann.*, ci, 387.

[Note. Very numerous and carefully made analyses of the salts of the ammonia-cobalt bases executed in my laboratory indicate 29·5 as the true equivalent of cobalt, and, to say the least, render a re-investigation of the subject very desirable.—w. g.]

2. *On the preparation of pure compounds of Cerium.*—Bunsen has given a method of preparing the compounds of cerium free from lanthanum and didymium which appears to possess great advantages over those already known. The method in question is based upon the fact that protoxyd of cerium, like protoxyd of manganese, when heated in the air with magnesia or oxyd of zinc becomes peroxydized and unites with the stronger base. The simplest mode of applying the principle is the following. The solution of the raw sulphates of cerium, didymium and lanthanum is to be treated with sulphydric acid to separate copper, &c., and then, after addition of a considerable quantity of chlorhydric acid, precipitated by oxalic acid. The mixed oxalates, which are now perfectly free from iron, are to be washed by decantation, dried, mixed with half their weight of pure magnesia-alba, and then heated in a porcelain capsule over an open fire with constant stirring. The bottom of the capsule must be just faintly red. In this manner a cinnamon-brown powder is obtained which contains all the cerium as sesquioxyd. The mass is to be heated with hot nitric acid which gives a fine red solution like that of bichromate of potash. On evaporation this gives a beautiful double nitrate of sesquioxyd of cerium and didymium and of the protoxyds of magnesium and lanthanum. The red nitric solution is to be diluted with much water,

ated to boiling, and then treated with small quantities of sulphuric acid there is no longer any increase of the precipitate formed. The cerium :n this way precipitated perfectly pure as a basic sesqui-salt in the form a yellowish-white flocky mass, which is easily washed by decantation th hot water containing a little sulphuric acid. When this basic salt is solved in strong sulphuric acid and then reduced by sulphurous acid, yields with oxalic acid chemically pure oxalate of protoxyd of cerium. e liquid from which the oxyd of cerium has been separated has usually leep reddish violet color and contains a higher oxyd of didymium, as ll as lanthanum, magnesium and cerium. This liquid when evapora- l yields a very beautiful double nitrate of lanthanum, didymium and ignesium which forms the starting point of a series of double nitrates.

Bunsen finds that when pure oxalate of protoxyd of cerium is ignited a platinum crucible in presence of air, a compound of protoxyd and quioxyd Ce_3O_4 remains, which is white with a shade of yellow. This yd becomes deep orange-red on heating, but recovers on cooling its ginal color. Boiling concentrated sulphuric acid dissolves it to form orange-red salt which dissolves in water with a yellow color. Chlor- dric and nitric acids scarcely act upon the oxyd even at the boiling point, t a mixture of iodid of potassium and chlorhydric acid dissolves it en in the cold with separation of iodine. The author employed this iction to determine the equivalent of cerium, which was found to be 5·8 (O=100) or 46·06 (O=8) as a mean of three experiments.—*Ann.* · *Chemie und Pharmacie*, cv, 40, January, 1858. W. G.

II. GEOLOGY.

1. *Fossils of Nebraska*, (1.) Letter from F. B. MEEK and F. V. HAYDEN G. K. WARREN, Lieut. Topog. Eng., dated Washington, February 8th, 58; printed in the National Intelligencer of March 16.—We have imined the fossils and other geological specimens collected under your ection during the past season in and near the Black Hills, Nebraska, l find that, in connexion with the facts noted, they indicate the follow- ; succession of geological formations in that region, viz.:

First. The main body or nucleus of the Black Hills is principally com- sed of a coarse feldspathic granite, which has been elevated by power- subterranean forces since the close of the Cretaceous Period, and pre- ous to the deposition of the Tertiary formations of the surrounding intry.

Superimposed upon the granite above-mentioned we have the following cending) series of stratified rocks:

1st. An ancient group of highly metamorphosed sedimentary forma- ns, usually observed standing nearly vertical.

2d. Reposing unconformably upon the latter a reddish and ash-colored idstone, thirty to fifty feet in thickness, equivalent to the Potsdam idstone of the New York Series; or, in other words, the oldest mem- r of the Silurian system. Amongst the specimens from this rock we :ognize *Lingula*, *Obolus?* and fragments of *Trilobites*, belonging to spe- s known to occur in the same formation in Wisconsin and Minnesota.

3d. A series of gray, reddish and whitish gritty limestones, sixty to e hundred feet in thickness, containing fossils which are clearly Carbon-

iferous, though we have not yet been able to determine definitely whether they are Lower or Upper Carboniferous forms; as they are for the most part badly preserved, and present apparently a mingling of Coal measure and Lower Carboniferous types.

4th. Two beds of a fine (rather incoherent) brick-red material, separated by from ten to fifty feet of bluish gray and reddish gritty limestone, containing specimens of a very small plicated *Rhynchonella*, a small *Pleurotomaria*, two species of *Macrocheilus*, and one or two species of *Bellerophon*, all apparently closely allied to Coal Measure forms.

The lower of the two brick-red beds above mentioned is from two hundred and fifty to three hundred feet in thickness, and appears to be destitute of organic remains, but contains more or less gypsum in the form of seams and thin beds; while the upper red bed, which is from one hundred to one hundred and fifty feet in thickness, is also apparently destitute of organic remains, and contains large quantities of gypsum.

These two red beds with the intermediate limestone may be of Permian age, though the generic and specific affinities of the fossils in the limestone point rather to the upper Carboniferous series. It is not improbable, however, that the upper of these two red beds may be Triassic or even Jurassic, as we have no palæontological data for determining its position in the geological column.

At some point along the southeast base of the Black Hills, loose masses of a hard flinty rock were found containing a few fossils of the same species, discovered by Major F. Hawn in northeastern Kansas, in beds now known to be of Permian age. These masses were not seen in place, and their position in relation to the other beds is consequently unknown.

5th. Above the upper of the two red beds already mentioned there are from one hundred to one hundred and fifty feet of strata, consisting of a series of bluish ash-colored and variegated argillaceous shaly beds, and dark-brown, reddish, gray, and yellowish sandstones, &c., containing *Lingula*, *Avicula*, *Arca*, *Belemnites*, *Ammonites*, *Pentacrinus*, &c., all of Jurassic types. From these facts, and the absence of Cretaceous species in this series, together with its stratigraphical position, we regard it as belonging to the Jurassic system.

6th. Then comes a series of strata, together about four hundred feet in thickness, very similar to the beds just mentioned, and not separated from them by any well-marked line of demarkation. In the lower part of this group, an *Ammonite*, a *Planorbis*, a *Paludina*, and a *Unio* were found, but most of the entire series of beds appear to be destitute of organic remains excepting fragments of vegetable matter. These beds we regard as probably belonging to the older Cretaceous, (No. 1 of the published sections of Nebraska Cretaceous formations,) though a large portion of them may be Jurassic.

Above all the foregoing formations we have in regular succession No. 2, No. 3, No. 4, and No. 5 of the Cretaceous series of Nebraska, as given in the published sections.

All these rocks, from the Potsdam sandstone to the most recent Cretaceous, inclusive, appear to repose conformably upon each other; and all, excepting the oldest metamorphic rocks and the Potsdam sandstone,

which were seen in the Black Hills, were usually met with around the base of these hills, dipping at high angles away from them, while the Tertiary formations were found to repose unconformably upon their upturned edges.

The Potsdam sandstone was frequently seen far up in the Black Hills, at an elevation of from five to eight hundred feet above the most modern Cretaceous and Tertiary beds of the surrounding country.

The granite forming the main body of the Black Hills, and portions of the adjacent stratified rocks, are traversed and rent at various places by numerous veins and dikes of basaltic and other igneous rocks.

(2.) Letter from Dr. J. Leidy to Lieut. G. K. Warren, U. S. Top. Eng.; (communicated for this Journal by Dr. F. V. Hayden.)—In accordance with your request, I send you a brief notice of the remains of extinct animals collected by Dr. F. V. Hayden in the Valley of the Niobara River, during your recent expedition to explore the region of the Black Hills, Nebraska. The opinion of the geologist of your expedition, Dr. Hayden, that the deposit from which the fossil bones were obtained is of pliocene age, appears to be borne out by the anatomical characters of the specimens. At least the remains indicate animals for the most part intermediate to those of the present period and those whose traces form rich deposits in the Miocene strata of the "Bad Lands" of Nebraska. A remarkable fact exhibited by the Niobara fossils, is, that the fauna of the Pliocene or later Tertiary period in this country, was much more nearly like the recent one of the Eastern hemisphere than our own recent indigenous fauna.

The collection is particularly rich in remains of ruminating and equine animals, which are mingled with those of several carnivorous and gnawing animals, and others of a Rhinoceros, a Mastodon and an Elephant.

Excepting a species of Deer, all the ruminant remains belong to extinct genera. One of these is especially interesting as it belonged to the Camel family and was about one-third less in size than the existing Camel.

Another genus was allied to the Musk-deer of Asia. A third genus, indicated by a few teeth, was larger than any living ruminant. The remaining genera, of which there are four species, belong to the same family as Oreodon of the Bad Lands formation. This family, now entirely extinct, consisted of what might be called ruminating hogs, or suiline animals with the peculiar ruminant habit.

Of equine animals the collection affords indications of no less than eight species of six genera. One of them was a horse undistinguishable by its remains from corresponding parts of the ordinary domestic animal; and a second was a horse not larger than a Newfoundland dog. Two of the species are allied to the more ancient equine genus *Anchitherium;* and two others are remarkable for having their milk teeth constructed after the plan of both sets in the latter genus, while their permanent teeth are like both sets in the recent horse. The remaining two species belong to the extinct genus *Hipparion*, common in the tertiary of Europe and Asia.

The Carnivora consist of four canine and two feline animals. Of the former one was a wolf larger than any living species, and another was a small species of fox. The gnawers consist of a small species of beaver and a species of porcupine.

The rhinoceros was about the size of the common species now living in India. The mastodon is a different species from that whose remains are so abundantly distributed through later formations of this country; and it was considerably smaller. The remains of the elephant indicate a species larger than any one yet discovered, extinct and recent.

Among the remains of mammals thus indicated there are mingled numerous fragments of bones of a large land turtle.

2. *Permian of Kansas and New Mexico.*—The discovery of the Permian in Kansas is announced in our last number by Prof. Swallow. A paper read before the Albany Institute by Meek and Hayden, and recently published (vol. iv. of Trans. Albany Institute, and read March 2,) announces the same discovery as an independent conclusion, and contains descriptions of *ten* new species of shells from the formation. The specimens, which enabled them to pronounce the rocks Permian were received from Major Hawn. The specimens are from near the Smoky Hill fork of Kansas river. The same rocks have also been observed near Helena 100 miles northeast; and near the boundary of Nebraska and Missouri.

On the 8th of March last, Dr B. F. Shumard announced to the Academy of Science at St. Louis, (see Proceedings of St. Louis Acad.,) that he had found the fossils which his brother Dr. G. G. Shumard had brought from a white limestone of the Guadalupe Mountains, New Mexico, to be in part identical with the Permian fossils of Kansas as well as those of England and Russia. The genus *Aulosteges* is represented, which has not been observed below the Permian. There are also the *Camaraphoria Schlotheimii*, *C. Geinitziana*, *Productus Leplayi*, *Terebratula elongata*, *T.* (*Spirigera*) *pectinifera*, *Spirifer cristata*, *Acanthocladia anceps*, *Synocladia*, *Monotis* near *M. speluncaria*, *Productus* near *P. Cancrini*; besides new species of *Productus*, *Spirifer*, *Chonetes*, *Trilobites*, and a slender *Fusulina* nearly two inches in length. According to the MS. Report of Dr. G. G. Shumard, this white limestone is more than a thousand feet thick. The fossils will soon be described.

Since the above was written, we have received a pamphlet by Prof. G. C. Swallow and Major F. Hawn treating of the Permian rocks of Kansas, enumerating near 80 species of fossils, and describing half of them as new. It is from the Transactions of the Acad. Sci. of St. Louis, vol. I, and was read February 22.

3. *Remains of Domestic Animals among Post-pliocene Fossils in South Carolina;* by Francis S. Holmes. 16 pp. 8vo. Charleston, 1858.—This paper contains an account of the observations of Mr. Holmes and also extracts from communications by Dr. Leidy and Professor Agassiz. The principal Post-pliocene locality of the fossils is at Ashley Ferry, South Carolina. Dr. Leidy, in his remarks on the fossils, states that the occurrence of the remains of an extinct species of horse in the post-pliocene of the country at different places has been recognized by various authors. At the Ashley deposit, it is plain that the remains of recent date and ancient species of animals are much mixed: but among them there is the extinct species of horse. The teeth hardly differ in any particular from those of the recent species; so that if identical with it, our horse existed here long antecedent to its introduction by the Europeans. The bluff where the specimens were obtained is about 30 feet high, the

base a pliocene limestone 15 feet thick, composed of marine shells, the remainder the post-pliocene layer consisting of ferruginous sand. The teeth are brown or black in color. The remains of a tapir also occur there, not distinguishable from the *Tapirus Americanus*. Dr. Leidy states that he has seen remains of this tapir from Texas, Louisiana, Kentucky, Mississippi, Indiana, Ohio and South Carolina. He observes that the same locality affords remains of the *Lepus sylvaticus* or common gray rabbit, fragments of teeth of the *Megatherium*, and the *Mylodon Harlani*. The shells of the post-pliocene are at least 95 per cent living; two now live on the coast of Florida, and two appear to be actually extinct.

Mr. Holmes enumerates other species of bones, and although there is still some little doubt (as both Dr. Leidy and Prof. Agassiz imply,) with regard to the identification of some of the species with the modern, he gives the following as his own conclusions respecting the mammals of the post-pliocene in North America. *Extinct species:* Mastodon, Megatherium, Megalonyx, Glyptodon, Mylodon, Hipparion (2 species).—*Species now existing on the Continent but not found on the Atlantic coast:* Bison, Tapir, Peccary, Beaver, Musk-rat, Elk.—*Species now known near the coast:* Deer, Raccoon, Opossum, Rabbit.—*Domestic Animals:* Horse, Hog, Sheep, Dog and Ox.

4. *On the slow rise of the shores of the Baltic*, (Acad. Sci., St. Petersburg, Bib. Univ. Gen., 1857, xxxv, 299).—Many facts have been collected recently by M. Kosakewitsch, and discussed by M. Hallström, relative to the rising of the coasts of Sweden and Finland. The following changes have been ascertained:—At Abo, from 1750 to 1841, 1·75 feet Swedish (a Swedish foot = 11·69 English inches); at Hangö-Udd, from 1754 to 1831, 1·67 Sw. feet; at Jussari, from 1800 to 1837, 0·74 feet; at Sweaborg, from 1800 to 1840, 0·80 feet. The coasts of Sweden and Finland are rocky and granitic and hence afford sure marks for such observations.

5. *Mean density of the Earth.*—Captain W. S. Jacob in a paper before the Royal Society (Phil. Mag., [4], xiii, 535) discusses the different methods of measuring the earth's mean density, and decides that the Cavendish method is the most to be relied on. He concludes his paper with the remark that there are hardly sufficient grounds for impugning the correctness of the value 5·67, deduced by the late Francis Baily from his carefully conducted repetition of the Cavendish experiment.

6. *Cretaceous Fossils from Vancouver Island.*—Andrew Murray, Esq., (Ed. New Phil. J., [2], vi, 168) announces the occurrence of Cretaceous fossils on Vancouver Island, *Ammonites*, *Baculites* (B. ovatus, Say), *Diceras*, *Venus*, *Unicardium*, *Psammobia*.

7. *Temperature of the Earth at great depths.*—Walferdin has published the results of observations on the temperature of the earth's crust made at Creuzot (Comp. Rend., May 11, 1857) where there are borings for coal. At Mouillonge, three kilometers from Creuzot, the boring descends 816 meters, from a point 321 meters above the sea-level; and at Torcy, a mile from Mouillonge, another boring descends 595 meters (into the coal) from a point 310 meters above the sea. The average increase of temperature on the descent is 1° C. in 30 or 31 meters; but between 550 and 800 meters, it is 1° C. in 23·6 meters.

8. *Geological Survey of Canada. Report of Progress for the years* 1853-56; by Sir W. E. LOGAN, Provincial Geologist. Printed by order of the Legislative Assembly. 494 pp., 8vo, with maps, and a quarto volume of plans of various lakes and rivers between Lake Huron and the river Ottawa. Toronto, 1857.—This Report covers four years of exploration. As in all the labors of the author, there is evidence of careful research and sure progress. The Special Report of Sir W. E. Logan covers the first 50 pages. It takes up especially the arrangement of the crystalline limestone among the other Laurentian (Azoic) rocks, and especially its condition in the vicinity of Grenville. The limestone occurs in bands that are nearly parallel, and which are so related as to leave no doubt that one or more strata of limestone are there folded up among the crystalline rocks. In Grenville there are two such bands about two miles apart, having a N.N.E. strike, and dipping, like the included gneiss, to the N.N.W. 50° to 70°. To the rear of the township the two unite and have a thickness of 500 to 1000 feet. Other similar bands and patches occur to the northward and eastward of these, which have approximately the same strike, and confirm the view that the Azoic of the region, before its crystallization, contained one if not two or more thick strata of limestone. The author discusses the precise character of these folds and illustrates the subject by means of a map of the region on which the bands of limestone are represented in color.

The Reports of A. Murray for the years 1853 to 1856 occupy pages 59 to 190, and contain details respecting the topography and geology of the region west of the Ottawa and north of Lake Huron. These are followed by Mr. James Richardson's Report on the *Island of Anticosti*, and the Mingan Islands in the Gulf of St. Lawrence, and the Palæoutological Report of E. Billings, Esq. The island of Anticosti is covered by fossiliferous strata referred to a period uniting the Lower and Upper Silurian; t e rock is an argillaceous limestone 2300 feet in thickness, throughout conformable and nearly horizontal. E. Billings, Esq., observes, p. 249, "All the facts tend to show that these strata were accumulated in a quiet sea, in uninterrupted succession during that period in which the upper part of the Hudson river group [Lower Silurian], and the Oneida conglomerate, the Medina sandstone and the Clinton group [Upper Silurian], were in the course of being deposited in that part of the Palæozoic ocean now constituting the State of New York and some of the countries adjacent." The fossils of the middle portion fill up the blank with the Upper and Lower Silurian, combining many of the Hudson river group with those of the Clinton, with the addition of other species unknown to both.

In the two lower divisions (900 feet) the fossils that are of known species have been found in the Hudson or Trenton group, with three exceptions, the *Heliolites megastoma*, *Catenipora escharoides* and *Favosites favosa*, not before known to extend into the Lower Silurian. Singular tree-like fossils (*Beatricea*) occur 430 feet from the base. They are straight stems 1 to 14 inches in diameter, tubular, with the tube transversely septate, the structure in layers resembling in this respect an exogenous tree. 950 feet above the base there are three additional Upper Silurian fossils, *Leptæna subplana*, *Strophomena depressa* and *Atrypa naviformis*. In the upper 600 feet, 60 species of fossils were collected,

and 20 out of the 24 hitherto described occur in the Clinton group, while 12 of the 24 are found also in the beds below. The following are the names of the 24 species; those in *italics* occur also in the lower beds of Anticosti, and those marked with an asterisk, are known as species of the Clinton group. *Chaetetes Lycoperdon,** *Catenipora Escharoides,** *Favosites favosa*, Zaphrentis bilateralis,* *Orthis Lynx,** O. elegantula,* O. Flabellulum, *Leptæna subplana,** L. transversalis, *L. profunda, Strophomena alternata,** *S. depressa,** *Atrypa reticularis,** *A. congesta,** A. plicatula,* A. hemispherica,* *A. naviformis,** Spirifer radiatus,* Pentamerus oblongus,* *Murchisonia subulata,** Cyclonema cancellata,* Platyostoma hemispherica, *Calymene Blumenbachii,** Bumastes Barriensis.*

Dr. Billings describes a number of new Cystideæ and Asteriadæ, from the Silurian of Canada, besides various Brachiopods and other molluscs. The genus *Huronia* he refers to Orthoceras (or *Ormoceras* if that genus be retained).

Next follows the Report of T. Sterry Hunt, Chemist and Mineralogist to the Geological Survey. We have already quoted a few facts on minerals from this report; also at page 217 an article on Ophiolites, and page 361 a chapter on the Salines of Europe. We propose to cite farther on the subject of rocks at another time. There are also valuable chapters on the Metallurgy of Iron, Magnesian Mortars, the Purification of Plumbago, and Peat and its products, which we must pass by.

On the subject of metamorphism, Mr. Hunt adopts the view that the changes were produced by the action of chemical solutions, without the agency of a very elevated temperature. But he writes (p. 477) as if this general idea were original with him, when it is the burden of Bischof's great work, who makes all rocks by water and chemistry; and moreover it seems to be now the prevalent opinion on the subject. Bischof's theory respecting the agency of chemical solutions,—alkaline silicates and carbonates, etc.—is briefly considered in the writer's Mineralogy, 4th edition, (1854), p. 227, and its application to metamorphism is especially recognized on page 226. The writer suggested this general view of metamorphism in this Journal in 1844, volume xlv, p. 104, and again in 1845, vol. xlvii, 135, and xlviii, 83, 92, and 397: at page 83, the agency of alkaline silicates is recognized in pseudomorphism (though the method of their action is not specifically explained); and, on page 92 of the same paper, metamorphism is spoken of as pseudomorphism on a broad scale. Forchhammer in 1844, in the Proceedings of the British Association, has an important paper bearing the same general direction, although differing in deriving the alkalies in part through vapors. We might mention other authorities, but it is not necessary here. The agency of organic matters in iron depositions, which Mr. Hunt also brings out, is discussed and sustained in Bischof, English edition, page 166. While making these claims for others, we do not overlook the fact that Mr. Hunt has brought forward important original views on the special action of the alkaline silicates and carbonates in metamorphism, and is aiding in giving the theory a satisfactory basis.

The quarto volume of twenty maps of the various lakes and rivers between Lake Huron and the Ottawa, by Mr. Murray, show that the Canadian government is carrying forward the survey on the right plan—a

union of geographical and geological investigations. The maps are of large size, nearly two feet by three, and contain particulars respecting the rocks of the regions, besides the usual map details, and in both respects a large amount of work has been ably performed.

9. *Iowa Geological Survey.*—The publication of the Annual Report of the Geological Survey of Iowa by the Geologist of the Survey, J. D. Whitney, and Palæontologist, James Hall, is already far advanced. The volume, we learn, promises to be one of the most important issued on American geology. The palæontology will be illustrated by 30 plates executed in fine style. We learn from Mr. T. S. Parvin of Iowa, that 250 copies will be placed at the disposal of the Governor of the State for the purpose of exchange with the other States of the country and with foreign countries, as well as various scientific societies; and that the State Historical Society will receive 30 copies for a similar purpose. Mr. Parvin also mentions that he will have ten copies for exchange with scientific authors.

10. *The Chemistry and Metallurgy of Copper, including a description of the principal Copper mines of the United States and other countries, the art of Mining and preparing ores for market, and the various processes of Copper Smelting, &c.;* by A. Snowden Piggot, M.D., of Baltimore. Philadelphia: Lindsay & Blakiston. 1858. 18mo, pp. 388.—This manual will be an acceptable addition to the literature of a branch of chemistry which has many claims to popular consideration. It presents in an untechnical and carefully prepared form much valuable information on the subjects of which it treats, on the chemical relations of copper; the ores of copper; the analysis of copper ores; mines and mining; mines of copper; copper smelting, and the alloys of copper. The author, from his official connection as assayer to one of the chief smelting works in the United States, has enjoyed good advantages for gaining exact information upon many of the topics of which he treats, and he has the faculty of stating his subject in a clear and simple manner. The statements are necessarily brief, and to the expert may convey little new. But to the general reader and those seeking a concise statement of the present state of knowledge on the subjects named, the author has made a valuable contribution.

11. *The Wheatley Collections.*—The well known mineralogical and conchological cabinets collected by Chas. M. Wheatley, Esq., of N. Y., have been purchased for Union College at Schenectady for the sum of ten thousand dollars. This sum was paid by E. C. Delavan, Esq., of Albany, and the collections were generously presented by him to Union College, where they have already arrived. These collections are among the best in the United States.

12. *Third Report of the Geological Survey in Kentucky, made during the years* 1856 *and* 1857; by David Dale Owen, Principal Geologist, assisted by R. Peter, Chemical Assistant, Sidney S. Lyon, Topographical Assistant, Leo Lesquereux and E. T. Cox, Palæontological Assistants. 1 vol. text, large 8vo, 590 pp., with a vol. (portfolio) in 8vo, of 10 plates and a map.—In our last number we noticed the publication of the second volume of the Kentucky Survey; and another two months have brought out a volume even larger, with ten plates of fossils. The volume

mmences with the General Report of Dr. Owen, in which he reviews
 observations on the coal measures, and the economical and strati-
phical geology. The chemical report of Dr. Peter contains the results
220 analyses, comprising soils, rocks, coals, iron ores, mineral waters,
., and covers 250 pages of the volume. S. S. Lyon presents a contin-
tion (from vol. ii) of the Topographical Geological Report of the sur-
y in the counties of Greenup, Carter, Lawrence and Hancock, for the
ar 1857, containing geological sections as well as facts bearing on the
ography; and following this, a Report on the Palæontology, contain-
 descriptions of new species of Crinoids, which are beautifully figured
 five plates. Mr. Leo Lesquereux follows with a brief but most valua-
 report on the Coal Measures and their Flora. No person in the
intry is better able to write on the subject, and great results will come
m his continued contributions to the survey. We propose to notice
ther his results in another number. The volume closes with the Palæ-
tological Report of Carboniferous Mollusca by Edward T. Cox, in which
ny species are described, figures of which occupy three plates. The
ence of the land and world, and not less the welfare of the State of
ntucky, are interested in the successful prosecution of the Kentucky
ological Survey.

13. *Descriptions of New Fossils from the Coal Measures of Missouri d Kansas;* by B. F. Shumard and G. C. Swallow. 32 pp., 8vo. tr. from Trans. Acad. Sci. St. Louis, Vol. I, No. 2. St. Louis, Missouri, 58.—This paper contains descriptions of 60 species of Carboniferous ecies of Mollusks, Crinoids, and Crustaceans from Missouri and the ter-ory of Kansas.

III. ASTRONOMY.

1. *Two new Planets*, (Gould's Astr. Jour., No. 111).—The *fifty-first* inet of the asteroid-group was discovered January 22, 1858, by Mr. .urent, at the observatory of Professor Valz at Nismes. Its apparent ignitude is 11–10, and it has been named *Nemausa.*

The *fifty-second* of the group was discovered February 4, 1858, by r. Goldschmidt, at Paris.

The names of the asteroidal planets discovered since Ariadne (43), are follows: Nysa (44), Eugenia (45), Hestia (46), Aglaia (47), Doris (48), iles (49), Virginia (50), Nemausa (51). The name of (52) has not yet iched us.

2. *First Comet of* 1858, (Gould's Astron. Jour., 109, 111).—This met was detected by Mr. H. P. Tuttle, at Cambridge, Mass., Jan. 4, 1858, d was independently found, Jan. 11, by Dr. Bruhns at Berlin.

The parabolic elements deduced by Dr. Bruhns from the Berlin and tona observations, resemble so closely those of the first comet of 1785 at he thinks the two comets to be identical. But the parabolic ele-ents obtained by Mr. James C. Watson (assistant in the Observatory of University of Michigan at Ann Arbor,) from the Cambridge observa-n of Jan. 4, and the Ann Arbor observations of Jan. 19 and Feb. 3 are strikingly similar to the elements of the second comet of 1790 that he nsiders the identity of the two comets as being beyond a doubt. From Cambridge observation of Jan. 4, and Ann Arbor observations of

Jan. 30 and Feb. 24 he has computed the following set of elliptic elements, viz:

Epoch, 1858, Jan. 30·5, Washington m. t.

Mean anomaly, - - - -	358° 19′ 22·23	
Long. of perihelion, - - - -	115 46 34·9	M. eqx.
" " asc. node, - - -	269 1 30·9	1858·0
Inclination, - - - - -	54 25 49·1	
Angle of excentricity, - - -	55 23 41·4	
Excentricity, - - - - -	0·823086	
Log. semi-axis major, - -	0·763343	
" mean daily motion, - -	2·404992	
Mean daily motion, - -	254″·0924	
Motion, - - - - - -	direct.	

The resulting period of revolution being 5101 days, the comet must have returned four times between 1790 and 1858, without detection.

3. *Second Comet of* 1858, (Lond. Athen., No. 1586).—A new comet, having the look of a large, pale nebula was discovered March 8, 1858, by Dr. A. Winnecke, of the Observatory at Bonn.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Annual Variations of Atmospheric Pressure in the Gulf of St. Lawrence;* by WILLIAM KELLY, M.D., R. N., (Proc. Roy. Irish Acad., iii, 3).—The table which accompanies this paper is an abstract from the "Meteorological Journal of the Naval Surveying Party" on the St. Lawrence. The observations from which it is taken extend over nine years, from 1841 to 1850. They were made on board the Gulnare surveying vessel, from the end of May in each year, to the middle of October; and during the remainder of the year at Charlotte Town, Prince Edward Island, where the party wintered.

Two ordinary marine barometers were employed in making these observations. The first got out of order in June, 1845, and the second was not obtained until the September following. The indications of the latter were somewhat lower than those of the first, which agreed generally with other barometers of the same construction. There was no apparent difference, however, in the range of the instruments, which, it is scarcely necessary to say, was less than the true range; not only on account of the varying level of the mercury in the bag, according as it ascends or descends in the tube; but also from hygrometric causes acting on the bag itself; the instruments having been kept in the moist air of a vessel at sea during the summer, and in the dry air of a house warmed by stoves during the winter.

From the mean of all the observations we find that the atmospheric pressure is least in January, February and March; that it increases slowly in April and May, and that there is a very slight decrease (·01) in June; that the pressure is greatest in July, August and September, after which it decreases gradually through the three remaining months of the year.

The annual course of atmospheric pressure which we find here, on the northeast coast of America, derives interest from the fact that a similar course has been as yet observed only at Sitka, on the extreme northwest of the continent, and in Europe at considerable mountain elevations.

Nothing apparently connected with it, either by similarity or contrast, has been observed on the mainland of North America; but in the sea to the north of the continent, which in following the coast-line may be said to lie between Norfolk Sound and the Gulf of St. Lawrence, we find an annual course of atmospheric pressure, decidedly different from that which obtains in these seas.

Summary of Barometric Observations made in Charlotte Town, and the southern parts of the Gulf of St. Lawrence, between 1841 *and* 1850.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1841						29·964	29·[illegible]5	30·115	30·044	29·837	29·729	29·81[illegible]
1842	29·789	29·838	29·899	29·895	29·842	29·986	30·014	30·172	29·943	29·899	29·852	29·85[illegible]
1843	29·946	29·725	29·663	29·927	29·977	29·900	29·96[illegible]	30·120	30·020	29·843	29·857	29·9[illegible]
1844	29·657	29·928	29·923	30·070	29·927	29·970	29·93[illegible]	30·036	30·063	29·9[illegible]5	29·800	29·77[illegible]
1845	29·834	29·856	29·895	29·900	29·944	——	——	——	29·790	29·983	29·695	29·71
1846	29·554	29·590	29·716	29·776	29·736	29·803	29·750	29·817	29·803	29·873	29·704	29·51[illegible]
1847	29·610	29·623	29·520	29·503	29·790	29·847	29·903	29·959	29·883	29·821	29·761	29·77[illegible]
1848	29·820	29·435	29·682	29·782	29·704	29·773	29·90[illegible]	29·910	29·812	29·783	29·76[illegible]	29·78[illegible]
1849	29·617	29·837	29·813	29·583	29·817	29·769	29·87[illegible]	29·832	22·975	29·820	29·690	29·53
1850	29·730	29·561	29·470	29·530	29·720	29·748	29·797	29·724	29·791			
Means	29·737	29·722	29·725	29·791	29·829	29·863	29·903	29·972	29·901	29·872	29·764	29·74[illegible]

Mean of all the Observations reduced to the Level of the Sea.

Jan.	Feb.	March.	April.	May.	June	July.	Aug.	Sept	Oct.	Nov.	Dec.
29·781	29·766	29·769	29·835	29·873	29·863	29·903	29·972	29·901	29·894	29·806	29·792

From the observations carried on for three years, on board H. M. S. Investigator, in Melville Sound, and those of Capt. Parry, at Melville Island, we find that the barometer was always lowest in July, August and September; and comparatively high, although not highest, in January, February and March. The low state of the barometer in the former months was marked in all Parry's voyages; but from his observations, as well as from those made in the Investigator, the greatest height was in April and May.

It would seem that the annual course of atmospheric pressure, which prevails all over Asia (and which is the reverse of that observed in the Gulf of St. Lawrence), extends beyond the shores of Siberia, and is met in a modified form, on the American side of the Arctic Sea.

2. *The Hand-Book of Practical Receipts of every day use:* a Manual for the Chemist, Druggist, Medical Practitioner, Manufacturer, and Heads of Families;—comprizing the officinal medicines, their uses and modes of preparation; and formulæ for trade preparations; mineral waters; powders, beverages, dietetic articles, perfumery, cosmetics, &c. A glossary of the terms used in chemistry and medicine, including old names, contractions, vulgar and scientific denominations, with a copious index to all the preparations; by Thomas F. Branson. First American from the second London edition. Philadelphia: Lindsay & Blakiston. 1857. 18mo, pp. 307.—After reading this title, no one can ask for an analysis of the book. It is an excellent little volume, meeting exactly a want felt in every intelligent family for a reliable and condensed reference for exact information on the several subjects of which it treats. The author is no empyric but a well-read professional student, and his book bears testimony to his good sense as well as his professional knowledge.

3. *Report of the Superintendent of the U. S. Coast Survey for* 1856. 4to, pp. 358, and 67 maps, plans, &c.—Every year adds to the importance and interest of these reports. Published now since 1852 in quarto, and in a manner worthy of the dignity and importance of the subjects of which they treat, they form an annual contribution to the mass of original scientific material of the country second in interest and importance to no other. We have already, on page 315, given an abstract of this Report; and much of the matter of several of the most important chapters—on magnetism, the tides, &c., given in detail in vols. xxiii and xxiv—in several memoirs by the Superintendent. We have so lately reviewed in detail the history and results of this greatest of American scientific undertakings that we need do no more at present than congratulate the country that the present Report vindicates all that has been said of the importance of the work in every view, scientific, practical and patriotic.

4. *Reports of Explorations and Surveys to ascertain the most Practicable and Economical Route for a Railrord from the Mississippi river to the Pacific Ocean;* made under the direction of the Secretary of War, in 1853–4.—Volumes V. and VI. of this great work have recently been issued. We here give only the subject treated, intending to bring out the geological results in an article in our next number.

Vol. V.—1. Report of Lieut. R. S. Williamson, U. S. Topog. Eng.

2. Geological Report, by W. P. Blake, Geol. and Mineralogist to the Expedition.

3. Botanical Report by E. Durand and T. C. Hilgard.

4. Appendices. (A) Distances and Altitudes; (B) Latitudes and Longitudes; (C) Data for Profiles.

Vol. VI.—1. Report by Lieut. Williamson, U. S. Topog. Eng. and H. L. Abbot, U. S. Topog. Eng.

2. Geological Report by J. S. Newberry.

3. Botanical Report by J. S. Newberry.

4. Zoological Report, by C. Girard and J. S. Newberry.

5. Appendices. (A) Astronomical observations with the Sextant. (B) List of camps, distances, altitudes, latitudes and longitudes, when astronomically determined, &c. (D) Barometrical and Thermometrical observations. (E) Observations for determining the horary oscillation of the barometric column. (F) Data for constructing Profiles of the routes proposed for a railroad.

The volumes are of high scientific value, and afford a better return for the expenditure than a large part of the results from government outlays.

5. Obituary.—S. G. Deeth, well known as a bibliopolist for many years past, died at his residence in Georgetown, D. C., on the 26th of February last. Mr. Deeth was one of the most intelligent and persevering book-collectors of this country, and has accumulated a very valuable collection, particularly of American periodicals, which was, in some respects, one of his prominent specialities.—*Am. Publishers' Circular, March* 6.

Carl Friedrich Plattner, Professor at Freiberg, and author of the great work on the Blowpipe, died on the 22d of January last. He was born on the 2d of January, 1800.

6. *Discovery of the Permian in Kansas.*—There appears to be some dispute as to priority in this discovery. The actual difference in the date of publication is but a few days (see p. 305*, Appendix to the March number, and page 442 of this number): and Mr. Hawn states that Messrs. Meek and Hayden had full liberty to publish the results of their examination of his fossils. The honor of having discovered the Kansas fossils belongs by general consent to Mr. Hawn; and the honor of first determining their age, claimed by both Prof. Swallow and Messrs. Meek and Hayden, is not diminished to either party by their sharing it together.

Bibliography, by J. Nicklès.

MALLET-BACHELIER, *Quai des Augustins, Paris, has recently published:*

T. B. Biot: Traité d'Astronomie physique; 5 vols. in 8vo, with an atlas. 3d edition, corrected and enlarged.

G. Lamé: Leçons sur les fonctions inverses des transcendentes et les surfaces isothermes. 1 vol. 8vo, 1857. Foreseeing that elliptical transcendentals of the 1st kind and their inverse functions will soon be introduced into class instruction, Mr. Lamé has prepared this work as a guide to the study. He is Professor in the "Ecole Polytechnique," and is especially appreciated for the precision and originality of his methods.

Darcy: Recherches expérimentales relatives au mouvement de l'eau dans les tuyaux. 1 vol. in 4to, with an atlas. Paris, 1857. This great work by Mr. Darcy, Inspector of Roads and Bridges, patronized by the Academy of Sciences, has been called forth by the necessity of verifying the laws deduced by Mr. de Prony from the few trials of the different experimenters known in his time. Having charge of the waters of the city of Paris, Mr. Darcy has taken advantage of his opportunities to investigate this subject from its foundation. The volume published contains his results. It will probably be followed by researches on the movement of water in canals or conduits.

Babinet et Housel: Calculs Pratiques appliqués aux Sciences d'observation. 1 vol., 8vo, 1857. Contains all the data which are of continual use in approximations, interpolations, applications of algebra, geometry and trigonometry, and in the establishment of physical laws. Consulting it will often save from long and troublesome researches.

Leçons de Céramique professées a l'Ecole Centrale des Arts et Manufactures, par M. Salvetat. 1857. 2 vols. in 12mo.—Mr. Salvetat's position in the manufactory at Sèvres adds much to the interest of this work, which treats of the chemistry, technology, etc. in the fabrication and decoration of pottery.

LeVerrier: Annales de l'Observatoire de Paris, T. II.

Furiet: Elemens de Mécanique, in 8vo.

Babinet: Etudes et Lectures sur les Sciences d'observation, T. IV.

GIDE ET BAUDRY: Astronomic Populaire, par F. Arago, T. IV, 1857.

HACHETTE & CO., *Rue Pierre Surrazin, Paris:*

Ch. Jourdain: Le Budget de l'Instruction publique en France, 1 vol., 8vo, 1857. Mr. Jourdain holds one of the highest positions under the Minister of Public Instruction. The work treats of all the scientific and literary establishments in France, which have been in existence since the foundation of the University in 1808.

V. Bois: Les Chemins de Fer Français. A duodecimo pamphlet treating of the lines and times of the different roads of France.

L. Viardot: Les Musées de France, d'Angleterre, d'Italie, et d'Allemagne, Guide et Memento de l'Artiste et du Voyageur. 2nd edition. 4 vols. in 12mo.

Michelet: L'Oiseau, 1 vol. in 12mo de 330 pages.—Also, l'Insecte, 1 vol. in 12mo de 400 pp. Michelet is the great historian and man of letters. Taken by sickness from his library, he has devoted himself to the study of natural history. The works add nothing, it is true, to natural science; but they show the bird and insect under a poetical aspect, without regarding exactness of description.

BAILLIERE, *Rue Hautefeuille, Paris*, and H. BAILLIERE, *New York City:*

A. de la Rive: Traité d'Electricité théorique et appliquée, T. III.

VICTOR MASSON, *Place de l'Ecole de Médecine, Paris:*

Figuier: Exposition et Histoire des principales découvertes scientifiques modernes, T. IV.—This volume treats of the history of the electric machine, Leyden jar, lightning rod, and Volta's pile.

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